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(21) International Application Number: PCT/US98/24524 (22) International Filing Date: 23 November 1998 (23.11.98) (30) Priority Data: 08/968,800 22 November 1997 (22.11.97) US (71) Applicant: HYESEQ, INC. [US/US]; 670 Almanor Avenue, Sunnyvale, CA 94086 (US). (72) Inventors: DRMANAC, Radoje, T.; 850 East Greenwich Place, Palo Alto, CA 94303 (US). CRKVENJAKOV, Radomir; 762 Haverhill Drive, Sunnyvale, CA 94087 (US). DICKSON, Mark; Apartment #B, 1411 Gabilan Drive, Hollister, CA 95023 (US). DRMANAC, Snezana; 850 East Greenwich Place, Palo Alto, CA 94303 (US). LABAT, Ivan; 140 Acalanas Drive, Sunnyvale, CA 94086 (US). LESHKOWITZ, Dena; 678 Durshire Way, Sunnyvale, CA 94087 (US). KITA, David; 899 Bounty Drive, Foster City, CA 94404 (US). FORD, John; Apartment #402, 1380 Oak Creek Drive, Palo Alto, CA 94304 (US). (74) Agent: GRUPPI, Carol, M.; McCutchen, Doyle, Brown & Enersen, LLP, Three Embarcadero Center, San Francisco, CA 94111 (US).	(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i> <i>With amended claims.</i> Date of publication of the amended claims: 5 August 1999 (05.08.99)	
(54) Title: A NOVEL EGF MOTIF PROTEIN OBTAINED FROM A cDNA LIBRARY OF FETAL LIVER-SPLEEN (57) Abstract The present invention provides novel polynucleotides and proteins encoded by such polynucleotides, along with therapeutic, diagnostic and research utilities for these polynucleotides and proteins. In particular, the polypeptides of the invention comprise amino acid sequences with similarity to EGF-repeat domains.		

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AMENDED CLAIMS

[received by the International Bureau on 24 May 1999 (24.05.99);
original claims 1 and 20 amended; new claim 22 added;
remaining claims unchanged (2 pages)]

and the cDNA insert of clone pEGFR-HY1;

- m) the nucleotide sequence of SEQ ID NO:5;
- n) nucleotides 205-267 of the nucleotide sequence of SEQ ID NO:5;
- o) nucleotides 442-483 of the nucleotide sequence of SEQ ID NO:5;
- 5 p) nucleotides 487-588 of the nucleotide sequence of SEQ ID NO:5;
- q) nucleotides 601-708 of the nucleotide sequence of SEQ ID NO:5;
- r) nucleotides 727-846 of the nucleotide sequence of SEQ ID NO:5;
- s) nucleotides 862-981 of the nucleotide sequence of SEQ ID NO:5;
- t) nucleotides 1540-1599 of the nucleotide sequence of SEQ ID NO:5;
- 10 u) nucleotides 1729-1731 of the nucleotide sequence of SEQ ID NO:5;
- v) nucleotides 1291-1299 of the nucleotide sequence of SEQ ID NO:5;
- w) the nucleotide sequence of the cDNA insert of clone pEGFR-HY1; or
- x) the nucleotide sequence of the cDNA insert of clone pEGFR-HY2.

15 2. An isolated polynucleotide which hybridizes to the complement of the polynucleotide of Claim 1 under stringent hybridization conditions.

3. An isolated polynucleotide which comprises the complement of the polynucleotide of Claim 1.

20

4. A vector comprising the isolated polynucleotide of Claim 1 or 2.

5. An expression vector comprising the isolated polynucleotide of Claim 1 or 2.

25 6. A host cell genetically engineered to contain the polynucleotide of Claim 1 or 2.

7. A host cell genetically engineered to contain the polynucleotide of Claim 1 or 2 in operative association with a regulatory sequence that controls expression of the polynucleotide in the host cell.

30

- a) contacting a compound with a polypeptide of Claim 8, in a cell, for a time sufficient to form a polypeptide/compound complex, wherein the complex drives expression of a reporter gene sequence in the cell; and
- b) detecting the complex by detecting reporter gene sequence expression,
- 5 so that if a polypeptide/compound complex is detected, a compound that binds to a polypeptide of Claim 8 is identified.

17. A method of modulating activity of a polypeptide of Claim 8, comprising contacting a cell that expresses the polypeptide with a compound that modulates activity of the polypeptide for a time sufficient to modulate said activity.

10

18. A method of modulating activity of the polypeptide of Claim 8, comprising contacting the polypeptide with a compound that modulates activity of the polypeptide for a time sufficient to modulate said activity.

15

19. A method of producing the polypeptide of claim 8, comprising,

a) culturing the host cell of claim 7 for a period of time sufficient to express the polypeptide contained within said cell; and

b) isolating the peptide from the cell of step (a).

20

20. An isolated polynucleotide comprising the nucleic acid sequence of SEQ ID NOS: 2 or 5.

21. An isolated polypeptide comprising the amino acid sequence of SEQ ID NOS: 3, 4, 6 or amino acid residues of 1-502 of SEQ ID NO:4.

25

22. The use of a modulator of a polypeptide in Claim 8 to modulate the activity of the polypeptide expressed in a cell.

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**A NOVEL EGF MOTIF PROTEIN OBTAINED FROM A cDNA LIBRARY OF FETAL
LIVER-SPLEEN**

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1. RELATED APPLICATIONS

This patent application is a continuation-in-part of U.S. patent application Serial No. 08/968,800 filed November 22, 1997.

10

2. TECHNICAL FIELD

The present invention provides novel polynucleotides and proteins encoded by such polynucleotides, along with therapeutic, diagnostic and research utilities for these polynucleotides and proteins.

15

3. BACKGROUND ART

Technology aimed at the discovery of protein factors (including e.g., cytokines, such as lymphokines, interferons, CSFs and interleukins) has matured rapidly over the past decade. The now routine hybridization cloning and expression cloning techniques clone novel polynucleotides "directly" in the sense that they rely on information directly related to the discovered protein (i.e., partial DNA/amino acid sequence of the protein in the case of hybridization cloning; activity of the protein in the case of expression cloning). More recent "indirect" cloning techniques such as signal sequence cloning, which isolates DNA sequences based on the presence of a now well-recognized secretory leader sequence motif, as well as various PCR-based or low stringency hybridization cloning techniques, have advanced the state of the art by making available large numbers of DNA/amino acid sequences for proteins that are known to have biological activity by virtue of their secreted nature in the case of leader sequence cloning, or by virtue of the cell or tissue source in the case of PCR-based techniques. It is to these proteins and the polynucleotides encoding them that the present invention is directed.

30

4. DISCLOSURE OF THE INVENTION

The compositions of the present invention include novel isolated polypeptides, in particular, novel EGF-repeat-containing polypeptides, isolated polynucleotides encoding such

polypeptides, including recombinant DNA molecules, cloned genes or degenerate variants thereof, especially naturally occurring variants such as allelic variants, and antibodies that specifically recognize one or more epitopes present on such polypeptides.

The compositions of the present invention additionally include vectors, including expression vectors, containing the polynucleotides of the invention, cells genetically engineered to contain such polynucleotides and cells genetically engineered to express such polynucleotides.

The isolated polynucleotides of the invention include, but are not limited to, a polynucleotide encoding a polypeptide comprising the amino acid sequence of SEQ ID NOS: 3, or 6; a polynucleotide encoding a polypeptide comprising amino acid residues 1-502 of SEQ ID: 4 (The first amino acid residue in the sequence is designated as 1); a polynucleotide encoding a polypeptide comprising amino acid residues 1 -21 of SEQ ID NO: 6; a polynucleotide encoding a polypeptide comprising amino acid residues 80-93 of SEQ ID NO:6; a polynucleotide encoding a polypeptide comprising amino acid residues 95-128 of SEQ ID NO:6; a polynucleotide encoding a polypeptide comprising amino acid residues 133-168 of SEQ ID NO:6; a polynucleotide encoding a polypeptide comprising amino acid residues 175-214 of SEQ ID NO:6; a polynucleotide encoding a polypeptide comprising amino acid residues 220-259 of SEQ ID NO:6; a polynucleotide encoding a polypeptide comprising amino acid residues 446-465 of SEQ ID NO:6; or a polynucleotide encoding a polypeptide comprising amino acid residues 363-365 of SEQ ID NO:6

The isolated polynucleotides of the invention further include, but are not limited to a polynucleotide comprising the nucleotide sequence of SEQ ID NOS: 1, 2 or 5; a polynucleotide comprising nucleotides 205-267 of the nucleotide sequence of SEQ ID NO: 5 (The first nucleic acid residue of the sequence is designated as 1); a polynucleotide comprising nucleotides 442-483 of the nucleotide sequence of SEQ ID NO: 5; a polynucleotide comprising nucleotides 487-588 of the nucleotide sequence of SEQ ID NO: 5; a polynucleotide comprising nucleotides 601-708 of the nucleotide sequence of SEQ ID NO: 5; a polynucleotide comprising nucleotides 727-846 of the nucleotide sequence of SEQ ID NO: 5; a polynucleotide comprising nucleotides 862-981 of the nucleotide sequence of SEQ ID NO: 5; a polynucleotide comprising nucleotides

1540-1599 of the nucleotide sequence of SEQ ID NO: 5; a polynucleotide comprising
5 nucleotides 1729-1731 of the nucleotide sequence of SEQ ID NO: 5; or a polynucleotide
comprising nucleotides 1291-1299 of the nucleotide sequence of SEQ ID NO:5.

The polynucleotides of the present invention still further include, but are not limited to, a
polynucleotide comprising the nucleotide sequence of the cDNA insert of clone pEGFR-HY1
deposited with the American Type Culture Collection (ATCC; 10801 University Blvd.,
10 Manassas, Virginia, 20110-2209, U.S.A.); a polynucleotide comprising a nucleotide sequence of
the cDNA insert of clone pEGFR-HY2 deposited with the ATCC (10801 University Blvd.,
Manassas, Virginia, 20110-2209, U.S.A.); a polynucleotide comprising a nucleotide sequence
encoding a polypeptide comprising the amino acid sequence encoded by the cDNA insert of
clone pEGFR-HY1 ; a polynucleotide comprising the nucleotide sequence encoding a
15 polypeptide comprising the amino acid sequence encoded by the cDNA insert of clone pEGFR-
HY2; a polynucleotide comprising the full length protein coding sequence of SEQ ID NO: 6
which polynucleotide comprises the cDNA insert of clone pEGFR-HY2, nucleic acids 323-357
of SEQ ID NO: 5 and the cDNA insert of clone pEGFR-HY1; a polynucleotide comprising the
nucleotide sequence of the mature protein coding sequence of SEQ ID NO: 6 comprising the
20 cDNA insert of clone pEGFR-HY2, nucleic acids 323-357 of SEQ ID NO: 5 and the cDNA
insert of clone pEGFR-HY1. The polynucleotides of the present invention also include, but are
not limited to, a polynucleotide that hybridizes to the complement of the nucleotide sequence of
SEQ ID NOS: 1, 2 or 5 under stringent hybridization conditions; a polynucleotide which is an
25 allelic variant of any polynucleotide recited above; a polynucleotide which encodes a species
homologue of any of the proteins recited above; or a polynucleotide that encodes a polypeptide
comprising a specific domain or truncation of the polypeptide of SEQ ID NO: 3 or 6 or amino
acids 1-502 of SEQ ID NO: 4.

The polynucleotides of the invention additionally include the complement of any of the
30 polynucleotides recited above.

The isolated polypeptides of the invention include, but are not limited to, a polypeptide
comprising the amino acid sequence of SEQ ID NOS:3or 6; a polypeptide comprising amino
acid residues 1-502 of SEQ ID NO:4; a polypeptide comprising amino acid residues 1-21 of

SEQ ID NO: 6; a polypeptide comprising amino acid residues 80-93 of SEQ ID NO:6; a
5 polypeptide comprising amino acid residues 95-128 of SEQ ID NO:6; a polypeptide comprising
amino acid residues 133-168 of SEQ ID NO:6; a polypeptide comprising amino acid residues
175-214 of SEQ ID NO:6; a polypeptide comprising amino acid residues 220-259 of SEQ ID
NO:6; a polypeptide comprising amino acid residues 446-465 of SEQ ID NO:6; or a polypeptide
comprising amino acid residues 363-365 of SEQ ID NO:6.

10 The polypeptides of the present invention further include, but are not limited to, a
polypeptide comprising the amino acid sequence encoded by the cDNA insert of clone pEGFR-
HY1 deposited with the American Type Culture Collection (ATCC; 10801 University Blvd.,
Manassas, Virginia, 20110-2209, U.S.A.); a polypeptide comprising the amino acid encoded by
the cDNA insert of clone pEGFR-HY2 deposited with the ATCC (10801 University Blvd.,
15 Manassas, Virginia, 20110-2209, U.S.A.); a full length protein of SEQ ID NO:6 comprising the
amino acid sequence encoded by the cDNA insert of clone pEGFR-HY2, nucleic acids 323-357
of SEQ ID NO: 5 and the cDNA insert of clone pEGFR-HY1; or a mature protein coding
sequence of SEQ ID NO: 6 comprising the amino acid sequence encoded by cDNA insert of
clone pEGFR-HY2, nucleic acids 323-357 of SEQ ID NO: 5 and the cDNA insert of clone
20 pEGFR-HY1.

Protein compositions of the present invention may further comprise an acceptable carrier,
such as a hydrophilic, e.g., pharmaceutically acceptable, carrier.

The invention also relates to methods for producing a polypeptide comprising growing a
25 culture of the cells of the invention in a suitable culture medium, and purifying the protein from
the culture. Preferred embodiments include those in which the protein produced by such process
is a mature form of the protein.

Polynucleotides according to the invention have numerous applications in a variety of
techniques known to those skilled in the art of molecular biology. These techniques include use
30 as hybridization probes, use as oligomers for PCR, use for chromosome and gene mapping, use
in the recombinant production of protein, and use in generation of anti-sense DNA or RNA, their
chemical analogs and the like. For example, when the expression of an mRNA is largely
restricted to a particular cell or tissue type, polynucleotides of the invention can be used as

hybridization probes to detect the presence of the particular cell or tissue mRNA in a sample
5 using, e.g., in situ hybridization.

In other exemplary embodiments, the polynucleotides are used in diagnostics as expressed sequence tags for identifying expressed genes or, as well known in the art and exemplified by Vollrath et al., *Science* 258:52-59 (1992), as expressed sequence tags for physical mapping of the human genome.

10 The polypeptides according to the invention can be used in a variety of conventional procedures and methods that are currently applied to other proteins. For example, a polypeptide of the invention can be used to generate an antibody that specifically binds the polypeptide. The polypeptides of the invention having ATPase activity are also useful for inhibiting platelet aggregation and can therefore be employed in the prophylaxis or treatment of pathological
15 conditions caused by the inflammatory response. The polypeptides of the invention can also be used as molecular weight markers, and as a food supplement.

Methods are also provided for preventing, treating or ameliorating a medical condition which comprises administering to a mammalian subject a therapeutically effective amount of a composition comprising a protein of the present invention and a pharmaceutically acceptable
20 carrier.

In particular, the polypeptides and polynucleotides of the invention can be utilized, for example, as part of methods for stimulation of epithelial tissue growth, e.g., skin regeneration. The polypeptides and polynucleotides of the invention may, therefore, be utilized, for example,
25 as part of methods for tissue repair and regeneration, corneal transplant healing, burn treatment, skin graft production and administration, and wound healing, e.g., treatment of surgical incisions, and ulcers, such as stomach or diabetic ulcers. In addition, the polynucleotides and polypeptides of the invention can further be utilized, for example, as part of methods for the prevention and/or treatment of disorders involving cell fate and differentiation, such as
30 leukemias, as well as for the treatment of nervous disorders.

The methods of the present invention further relate to methods for detecting the presence of the polynucleotides or polypeptides of the invention in a sample. Such methods can, for example, be utilized as part of prognostic and diagnostic evaluation of disorders as recited above

and for the identification of subjects exhibiting a predisposition to such conditions.

5 Furthermore, the invention provides methods for evaluating the efficacy of drugs, and monitoring the progress of patients, involved in clinical trials for the treatment of disorders as recited above.

The invention also provides methods for the identification of compounds that modulate the expression of the polynucleotides and/or polypeptides of the invention. Such methods can be
10 utilized, for example, for the identification of compounds that can ameliorate symptoms of disorders as recited above. Such methods can include, but are not limited to, assays for identifying compounds and other substances that interact with (*e.g.*, bind to) the polypeptides of the invention.

The methods of the invention also include methods for the treatment of disorders as
15 recited above which may involve the administration of such compounds to individuals exhibiting symptoms or tendencies related to disorders as recited above. In addition, the invention encompasses methods for treating diseases or disorders as recited above by administering compounds and other substances that modulate the overall activity of the target gene products. Compounds and other substances can effect such modulation either on the level of target gene
20 expression or target protein activity.

5. BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows the sequence alignment of SEQ ID Nos. 3-4 with the EGF-repeat motifs of
25 *drosophila Notch*, CD97, and the consensus EGF-R repeat. A- Alanine; R- Arginine; N- Asparagine; D- Aspartic Acid; C- Cysteine; E- Glutamic Acid; Q- Glutamine; G- Glycine; H- Histidine; I- Isoleucine; L- Leucine; K- Lysine; M- Methionine; F- Phenylalanine; P- Proline; S- Serine; T- Threonine; W- Tryptophan; Y- Tyrosine; V- Valine; X - any of the twenty amino acids. Gaps are presented as spaces and nonconserved residues as dashes. Regions of SEQ ID
30 No. 4 are labeled 10244. Amino acid positions for location of the beginning of each protein stretch are provided. Notch, CD97, and EGF-R are labeled accordingly. Consensus sequences are labeled (C). The conserved cysteines and glycines are underlined.

FIG. 2 shows the nucleic acid sequences that were obtained from the b²HFLS20W cDNA

library using standard pcr, sequencing by hybridization signature analysis, and single pass gel
 5 sequencing technology. These sequences are designated as SEQ ID Nos. 1-2. A- adenosine; C-
 cytosine; G- guanosine; T- thymidine; and N- any of the four bases.

FIG. 3 shows SEQ ID NOS:3-4. The amino acid sequence of SEQ ID NO: 3
 corresponds to the polynucleotide sequence of SEQ ID NO. 1. Amino acid residues 1-502 of
 SEQ ID NO:4 correspond to the polynucleotide sequence of SEQ ID NO:2 and to amino acid
 10 positions 52-553 of of SEQ ID NO 6 (see FIG. 5). A- Alanine; R- Arginine; N- Asparagine; D-
 Aspartic Acid; C- Cysteine; E- Glutamic Acid; Q- Glutamine; G- Glycine; H- Histidine; I-
 Isoleucine; L- Leucine; K- Lysine; M- Methionine; F- Phenylalanine; P- Proline; S- Serine; T-
 Threonine; W- Tryptophan; Y- Tyrosine; V- Valine; X- any of the twenty amino acids.

FIG. 4 shows SEQ ID NO. 5, which is a five prime and three prime extension of the
 15 cDNA sequence, SEQ ID NO. 2.

FIG. 5 shows the amino-acid translation (SEQ ID NO:6) from nucleotide 205 to 1866 of
 SEQ ID NO. 5, including the starting methionine and stop codon. The first 21 amino-acids
 comprise the hydrophobic region that represents the signal peptide.

20 6. MODES FOR CARRYING OUT THE INVENTION

6.1. DEFINITIONS

The term "nucleotide sequence" refers to a heteropolymer of nucleotides or the sequence
 of these nucleotides. The terms "nucleic acid" and "polynucleotide" are also used
 interchangeably herein to refer to a heteropolymer of nucleotides. Generally, nucleic acid
 25 segments provided by this invention may be assembled from fragments of the genome and short
 oligonucleotide linkers, or from a series of oligonucleotides, or from individual nucleotides, to
 provide a synthetic nucleic acid which is capable of being expressed in a recombinant
 transcriptional unit comprising regulatory elements derived from a microbial or viral operon, or
 a eukaryotic gene.

30 The terms "oligonucleotide fragment" or a "polynucleotide fragment", "portion," or
 "segment" is a stretch of polypeptide nucleotide residues which is long enough to use in
 polymerase chain reaction (PCR) or various hybridization procedures to identify or amplify
 identical or related parts of mRNA or DNA molecules.

The terms "oligonucleotides" or "nucleic acid probes" are prepared based on the
5 polynucleotide sequences provided in the present invention. Oligonucleotides comprise portions
of such a polynucleotide sequence having at least about 15 nucleotides and usually at least about
20 nucleotides. Nucleic acid probes comprise portions of such a polynucleotide sequence having
fewer nucleotides than about 6 kb, usually fewer than about 1 kb. After appropriate testing to
eliminate false positives, these probes may, for example, be used to determine whether specific
10 mRNA molecules are present in a cell or tissue or to isolate similar nucleic acid sequences from
chromosomal DNA as described by Walsh et al. (Walsh, P.S. et al., 1992, PCR Methods Appl
1:241-250).

The term "probes" includes naturally occurring or recombinant or chemically synthesized
single- or double-stranded nucleic acids. They may be labeled by nick translation, Klenow fill-
15 in reaction, PCR or other methods well known in the art. Probes of the present invention, their
preparation and/or labeling are elaborated in Sambrook, J. et al., 1989, Molecular Cloning: A
Laboratory Manual, Cold Spring Harbor Laboratory, NY; or Ausubel, F.M. et al., 1989, Current
Protocols in Molecular Biology, John Wiley & Sons, New York NY, both of which are
incorporated herein by reference in their entirety.

20 The term "stringent" is used to refer to conditions that are commonly understood in the
art as stringent. Stringent conditions can include highly stringent conditions (*i.e.*, hybridization
to filter-bound DNA under in 0.5 M NaHPO₄, 7% sodium dodecyl sulfate (SDS), 1 mM EDTA
at 65° C, and washing in 0.1xSSC/0.1% SDS at 68° C), and moderately stringent conditions (*i.e.*,
25 washing in 0.2xSSC/0.1% SDS at 42° C).

In instances wherein hybridization of deoxyoligonucleotides is concerned, additional
exemplary stringent hybridization conditions include washing in 6xSSC/0.05% sodium
pyrophosphate at 37°C (for 14-base oligos), 48°C (for 17-base oligos), 55°C (for 20-base
oligos), and 60°C (for 23-base oligos).

30 The term "recombinant," when used herein to refer to a polypeptide or protein, means
that a polypeptide or protein is derived from recombinant (e.g., microbial or mammalian)
expression systems. "Microbial" refers to recombinant polypeptides or proteins made in
bacterial or fungal (e.g., yeast) expression systems. As a product, "recombinant microbial"

defines a polypeptide or protein essentially free of native endogenous substances and
5 unaccompanied by associated native glycosylation. Polypeptides or proteins expressed in most
bacterial cultures, e.g., *E. coli*, will be free of glycosylation modifications; polypeptides or
proteins expressed in yeast will have a glycosylation pattern in general different from those
expressed in mammalian cells.

The term "recombinant expression vehicle or vector" refers to a plasmid or phage or
10 virus or vector, for expressing a polypeptide from a DNA (RNA) sequence. An expression
vehicle can comprise a transcriptional unit comprising an assembly of (1) a genetic element or
elements having a regulatory role in gene expression, for example, promoters or enhancers, (2) a
structural or coding sequence which is transcribed into mRNA and translated into protein, and
(3) appropriate transcription initiation and termination sequences. Structural units intended for
15 use in yeast or eukaryotic expression systems preferably include a leader sequence enabling
extracellular secretion of translated protein by a host cell. Alternatively, where recombinant
protein is expressed without a leader or transport sequence, it may include an N-terminal
methionine residue. This residue may or may not be subsequently cleaved from the expressed
recombinant protein to provide a final product.

20 The term "recombinant expression system" means host cells which have stably integrated
a recombinant transcriptional unit into chromosomal DNA or carry the recombinant
transcriptional unit extrachromosomally. Recombinant expression systems as defined herein
will express heterologous polypeptides or proteins upon induction of the regulatory elements
25 linked to the DNA segment or synthetic gene to be expressed. This term also means host cells
which have stably integrated a recombinant genetic element or elements having a regulatory role
in gene expression, for example, promoters or enhancers. Recombinant expression systems as
defined herein will express polypeptides or proteins endogenous to the cell upon induction of the
regulatory elements linked to the endogenous DNA segment or gene to be expressed. The cells
30 can be prokaryotic or eukaryotic.

The term "open reading frame," ORF, means a series of nucleotide triplets coding for
amino acids without any termination codons and is a sequence translatable into protein.

The term "expression modulating fragment," EMF, means a series of nucleotides which

modulates the expression of an operably linked ORF or another EMF.

5 As used herein, a sequence is said to "modulate the expression of an operably linked sequence" when the expression of the sequence is altered by the presence of the EMF. EMFs include, but are not limited to, promoters, and promoter modulating sequences (inducible elements). One class of EMFs are fragments which induce the expression of an operably linked ORF in response to a specific regulatory factor or physiological event.

10 As used herein, an "uptake modulating fragment," UMF, means a series of nucleotides which mediate the uptake of a linked DNA fragment into a cell. UMFs can be readily identified using known UMFs as a target sequence or target motif with the computer-based systems described below.

The presence and activity of a UMF can be confirmed by attaching the suspected UMF to
15 a marker sequence. The resulting nucleic acid molecule is then incubated with an appropriate host under appropriate conditions and the uptake of the marker sequence is determined. As described above, a UMF will increase the frequency of uptake of a linked marker sequence.

The term "active" refers to those forms of the polypeptide which retain the biologic and/or immunologic activities of any naturally occurring polypeptide.

20 The term "naturally occurring polypeptide" refers to polypeptides produced by cells that have not been genetically engineered and specifically contemplates various polypeptides arising from post-translational modifications of the polypeptide including, but not limited to, acetylation, carboxylation, glycosylation, phosphorylation, lipidation and acylation.

25 The term "derivative" refers to polypeptides chemically modified by such techniques as ubiquitination, labeling (e.g., with radionuclides or various enzymes), pegylation (derivatization with polyethylene glycol) and insertion or substitution by chemical synthesis of amino acids such as ornithine, which do not normally occur in human proteins.

The term "recombinant variant" refers to any polypeptide differing from naturally
30 occurring polypeptides by amino acid insertions, deletions, and substitutions, created using recombinant DNA techniques. Guidance in determining which amino acid residues may be replaced, added or deleted without abolishing activities of interest, such as cellular trafficking, may be found by comparing the sequence of the particular polypeptide with that of homologous

peptides and minimizing the number of amino acid sequence changes made in regions of high
5 homology.

Preferably, amino acid "substitutions" are the result of replacing one amino acid with
another amino acid having similar structural and/or chemical properties, i.e., conservative amino
acid replacements. Amino acid substitutions may be made on the basis of similarity in polarity,
charge, solubility, hydrophobicity, hydrophilicity, and/or the amphipathic nature of the residues
10 involved. For example, nonpolar (hydrophobic) amino acids include alanine, leucine,
isoleucine, valine, proline, phenylalanine, tryptophan, and methionine; polar neutral amino acids
include glycine, serine, threonine, cysteine, tyrosine, asparagine, and glutamine; positively
charged (basic) amino acids include arginine, lysine, and histidine; and negatively charged
(acidic) amino acids include aspartic acid and glutamic acid. "Insertions" or "deletions" are
15 typically in the range of about 1 to 5 amino acids. The variation allowed may be experimentally
determined by systematically making insertions, deletions, or substitutions of amino acids in a
polypeptide molecule using recombinant DNA techniques and assaying the resulting
recombinant variants for activity.

Alternatively, where alteration of function is desired, insertions, deletions or non-
20 conservative alterations can be engineered to produce altered polypeptides. Such alterations can,
for example, alter one or more of the biological functions or biochemical characteristics of the
polypeptides of the invention. For example, such alterations may change polypeptide
characteristics such as ligand-binding affinities, interchain affinities, or degradation/turnover
25 rate. Further, such alterations can be selected so as to generate polypeptides that are better suited
for expression, scale up and the like in the host cells chosen for expression. For example,
cysteine residues can be deleted or substituted with another amino acid residue in order to
eliminate disulfide bridges.

As used herein, "substantially equivalent" can refer both to nucleotide and amino acid
30 sequences, for example a mutant sequence, that varies from a reference sequence by one or more
substitutions, deletions, or additions, the net effect of which does not result in an adverse
functional dissimilarity between the reference and subject sequences. Typically, such a
substantially equivalent sequence varies from one of those listed herein by no more than about

20% (i.e., the number of individual residue substitutions, additions, and/or deletions in a substantially equivalent sequence, as compared to the corresponding reference sequence, divided
5 by the total number of residues in the substantially equivalent sequence is about 0.2 or less). Such a sequence is said to have 80% sequence identity to the listed sequence. In one embodiment, a substantially equivalent, e.g., mutant, sequence of the invention varies from a listed sequence by no more than 10% (90% sequence identity); in a variation of this
10 embodiment, by no more than 5% (95% sequence identity); and in a further variation of this embodiment, by no more than 2% (98% sequence identity). Substantially equivalent, e.g., mutant, amino acid sequences according to the invention generally have at least 95% sequence identity with a listed amino acid sequence, whereas substantially equivalent nucleotide sequence of the invention can have lower percent sequence identities, taking into account, for example, the
15 redundancy or degeneracy of the genetic code. For the purposes of the present invention, sequences having substantially equivalent biological activity and substantially equivalent expression characteristics are considered substantially equivalent. For the purposes of determining equivalence, truncation of the mature sequence (*e.g.*, via a mutation which creates a spurious stop codon) should be disregarded.

20 Nucleic acid sequences encoding such substantially equivalent sequences, e.g., sequences of the recited percent identities, can routinely be isolated and identified via standard hybridization procedures well known to those of skill in the art.

Where desired, an expression vector may be designed to contain a "signal or leader
25 sequence" which will direct the polypeptide through the membrane of a cell. Such a sequence may be naturally present on the polypeptides of the present invention or provided from heterologous protein sources by recombinant DNA techniques.

A polypeptide "fragment," "portion," or "segment" is a stretch of amino acid residues of at least about 5 amino acids, often at least about 7 amino acids, typically at least about 9 to 13
30 amino acids, and, in various embodiments, at least about 17 or more amino acids. To be active, any polypeptide must have sufficient length to display biologic and/or immunologic activity.

Alternatively, recombinant variants encoding these same or similar polypeptides may be synthesized or selected by making use of the "redundancy" in the genetic code. Various codon

substitutions, such as the silent changes which produce various restriction sites, may be introduced to optimize cloning into a plasmid or viral vector or expression in a particular prokaryotic or eukaryotic system. Mutations in the polynucleotide sequence may be reflected in the polypeptide or domains of other peptides added to the polypeptide to modify the properties of any part of the polypeptide, to change characteristics such as ligand-binding affinities, interchain affinities, or degradation/turnover rate.

10 The term "activated" cells as used in this application are those which are engaged in extracellular or intracellular membrane trafficking, including the export of neurosecretory or enzymatic molecules as part of a normal or disease process.

The term "purified" as used herein denotes that the indicated nucleic acid or polypeptide is present in the substantial absence of other biological macromolecules, *e.g.*, polynucleotides, proteins, and the like. In one embodiment, the polynucleotide or polypeptide is purified such that it constitutes at least 95% by weight, more preferably at least 99.8% by weight, of the indicated biological macromolecules present (but water, buffers, and other small molecules, especially molecules having a molecular weight of less than 1000 daltons, can be present).

20 The term "isolated" as used herein refers to a nucleic acid or polypeptide separated from at least one other component (*e.g.*, nucleic acid or polypeptide) present with the nucleic acid or polypeptide in its natural source. In one embodiment, the nucleic acid or polypeptide is found in the presence of (if anything) only a solvent, buffer, ion, or other component normally present in a solution of the same. The terms "isolated" and "purified" do not encompass nucleic acids or polypeptides present in their natural source.

25 The term "infection" refers to the introduction of nucleic acids into a suitable host cell by use of a virus or viral vector.

The term "transformation" means introducing DNA into a suitable host cell so that the DNA is replicable, either as an extrachromosomal element, or by chromosomal integration.

30 The term "transfection" refers to the taking up of an expression vector by a suitable host cell, whether or not any coding sequences are in fact expressed.

The term "intermediate fragment" means a nucleic acid between 5 and 1000 bases in length, and preferably between 10 and 40 bp in length.

The term "secreted" protein refers to a protein that is transported across or through a
5 membrane, including transport as a result of signal sequences in its amino acid sequence when it
is expressed in a suitable host cell. "Secreted" proteins include without limitation proteins
secreted wholly (e.g., soluble proteins) or partially (e.g., receptors) from the cell in which they
are expressed. "Secreted" proteins also include without limitation proteins which are transported
across the membrane of the endoplasmic reticulum.

10 Each of the above terms is meant to encompass all that is described for each, unless the
context dictates otherwise.

POLYNUCLEOTIDES AND NUCLEIC ACIDS OF THE INVENTION

Nucleotide and amino acid sequences of the invention are reported below. Fragments of
15 the proteins of the present invention which are capable of exhibiting biological activity are also
encompassed by the present invention. Fragments of the protein may be in linear form or they
may be cyclized using known methods, for example, as described in H. U. Saragovi, et al.,
Bio/Technology 10, 773-778 (1992) and in R. S. McDowell, et al., J. Amer. Chem. Soc. 114,
9245-9253 (1992), both of which are incorporated herein by reference. Such fragments may be
20 fused to carrier molecules such as immunoglobulins for many purposes, including increasing the
valency of protein binding sites. For example, fragments of the protein may be fused through
"linker" sequences to the Fc portion of an immunoglobulin. For a bivalent form of the protein,
such a fusion could be to the Fc portion of an IgG molecule. Other immunoglobulin isotypes
25 may also be used to generate such fusions. For example, a protein-IgM fusion would generate a
decaivalent form of the protein of the invention.

The present invention also provides both full-length and mature forms (for example,
without a hydrophobic signal peptide) of the disclosed proteins. The full-length form of the such
proteins is identified in the sequence listing by translation of the nucleotide sequence of each
30 disclosed clone. The mature form of such protein may be obtained by expression of the disclosed
full-length polynucleotide (for example, obtained from using the clones deposited with ATCC
using standard techniques) in a suitable mammalian cell or other host cell. The sequence of the
mature form of the protein is also determinable from the amino acid sequence of the full-length

form.

5 The present invention also provides genes corresponding to the cDNA sequences disclosed herein. The corresponding genes can be isolated in accordance with known methods using the sequence information disclosed herein. Such methods include the preparation of probes or primers from the disclosed sequence information for identification and/or amplification of genes in appropriate genomic libraries or other sources of genomic materials.

10 Where the protein of the present invention is membrane-bound (e.g., is a receptor), the present invention also provides for soluble forms of such protein. In such forms part or all of the intracellular and transmembrane domains of the protein are deleted such that the protein is fully secreted from the cell in which it is expressed. The intracellular and transmembrane domains of proteins of the invention can be identified in accordance with known techniques for
15 determination of such domains from sequence information.

Species homologs of the disclosed polynucleotides and proteins are also provided by the present invention. Species homologs may be isolated and identified by making suitable probes or primers from the sequences provided herein and screening a suitable nucleic acid source from the desired species.

20 The invention also encompasses allelic variants of the disclosed polynucleotides or proteins; that is, naturally-occurring alternative forms of the isolated polynucleotide which also encode proteins which are identical, homologous or related to that encoded by the polynucleotides.

25 The compositions of the present invention include isolated polynucleotides, including recombinant DNA molecules, cloned genes or degenerate variants thereof, especially naturally occurring variants such as allelic variants, novel isolated polypeptides, and antibodies that specifically recognize one or more epitopes present on such polypeptides.

Species homologs of the disclosed polynucleotides and proteins are also provided by the
30 present invention. Species homologs may be isolated and identified by making suitable probes or primers from the sequences provided herein and screening a suitable nucleic acid source from the desired species.

The invention also encompasses allelic variants of the disclosed polynucleotides or

proteins; that is, naturally-occurring alternative forms of the isolated polynucleotide which also
 5 encode proteins which are identical, homologous or related to that encoded by the
 polynucleotides.

6.2. NUCLEIC ACIDS OF THE INVENTION

The isolated polynucleotides of the invention include, but are not limited to
 10 polynucleotides encoding a polypeptide comprising the amino acid sequence of SEQ ID NOS:3
 or 6 or amino acid residues 1-502 of SEQ ID NO: 4 as well as polynucleotides which encode
 specific domains thereof. For example, a polynucleotide encoding a polypeptide comprising
 amino acid residues 1 -21 of SEQ ID NO: 6; a polynucleotide encoding a polypeptide
 comprising amino acid residues 80-93 of SEQ ID NO:6; a polynucleotide encoding a
 15 polypeptide comprising amino acid residues 95-128 of SEQ ID NO:6; a polynucleotide encoding
 a polypeptide comprising amino acid residues 133-168 of SEQ ID NO:6; a polynucleotide
 encoding a polypeptide comprising amino acid residues 175-214 of SEQ ID NO:6; a
 polynucleotide encoding a polypeptide comprising amino acid residues 220-259 of SEQ ID
 NO:6; a polynucleotide encoding a polypeptide comprising amino acid residues 446-465 of SEQ
 20 ID NO:6; or a polynucleotide encoding a polypeptide comprising amino acid residues 363-365
 of SEQ ID NO:6.

In particular embodiments, the isolated polynucleotides of the invention include, but are
 not limited to, a polynucleotide comprising the nucleotide sequence of SEQ ID NOS:1,2, or 5; a
 25 polynucleotide comprising nucleotides 205-267 of the nucleotide sequence of SEQ ID NO:5; a
 polynucleotide comprising nucleotides 442-483 of the nucleotide sequence of SEQ ID NO:5; a
 polynucleotide comprising nucleotides 487-588 of the nucleotide sequence of SEQ ID NO:5; a
 polynucleotide comprising nucleotides 601-708 of the nucleotide sequence of SEQ ID NO:5; a
 polynucleotide comprising nucleotides 727-846 of the nucleotide sequence of SEQ ID NO:5; a
 30 polynucleotide comprising nucleotides 862-981 of the nucleotide sequence of SEQ ID NO:5; a
 polynucleotide comprising nucleotides 1540-1599 of the nucleotide sequence of SEQ ID NO:5;
 a polynucleotide comprising nucleotides 1729-1731 of the nucleotide sequence of SEQ ID
 NO:5; or a polynucleotide comprising nucleotides 1291-1299 of the nucleotide sequence of SEQ

ID NO:5.

5 The polynucleotides of the present invention still further include, but are not limited to, a polynucleotide comprising the nucleotide sequence of the cDNA insert of clone pEGFR-HY1 deposited with the American Type Culture Collection (ATCC; 10801 University Blvd., Manassas, Virginia, 20110-2209, U.S.A.); a polynucleotide comprising the nucleotide sequence of the cDNA insert of clone pEGFR-HY2 deposited with the ATCC (10801 University Blvd.,
10 Manassas, Virginia, 20110-2209, U.S.A.); a polynucleotide comprising the nucleotide sequence encoding a polypeptide comprising the amino acid sequence encoded by the cDNA insert of clone pEGFR-HY1 ; a polynucleotide comprising the nucleotide sequence encoding a polypeptide comprising the amino acid sequence encoded by the cDNA insert of clone pEGFR-HY2; a polynucleotide comprising the full length protein coding sequence of SEQ ID NO: 6
15 which polynucleotide comprises the cDNA insert of clone pEGFR-HY2, nucleic acids 323-357 of SEQ ID NO: 5 and the cDNA insert of clone pEGFR-HY1; a polynucleotide comprising the nucleotide sequence of the mature protein coding sequence of SEQ ID NO: 6 which polynucleotide comprises the cDNA insert of clone pEGFR-HY2, nucleic acids 323-357 of SEQ ID NO: 5 and the cDNA insert of clone pEGFR-HY1.

20 The polynucleotides of the present invention also include, but are not limited to, a polynucleotide that hybridizes to the complement of the nucleotide sequence of SEQ ID NOS:1, 2 or 5 under stringent hybridization conditions; a polynucleotide which is an allelic variant of any polynucleotide recited above; a polynucleotide which encodes a species homologue of any
25 of the proteins recited above; or a polynucleotide that encodes a polypeptide comprising an additional specific domain or truncation of the polypeptide of SEQ ID NOS: 3 or 6, or amino acid residues 1-502 of SEQ ID NO:4.

The polynucleotides of the invention additionally include the complement of any of the polynucleotides recited above.

30 The polynucleotides of the invention also provide polynucleotides including nucleotide sequences that are substantially equivalent to the polynucleotides recited above. Polynucleotides according to the invention can have at least about 80%, more typically at least about 90%, and even more typically at least about 95%, sequence identity to a polynucleotide recited above. The

invention also provides the complement of the polynucleotides including a nucleotide sequence
5 that has at least about 80%, more typically at least about 90%, and even more typically at least
about 95%, sequence identity to a polynucleotide encoding a polypeptide recited above. The
polynucleotide can be DNA (genomic, cDNA, amplified, or synthetic) or RNA. Methods and
algorithms for obtaining such polynucleotides are well known to those of skill in the art and can
include, for example, methods for determining hybridization conditions which can routinely
10 isolate polynucleotides of the desired sequence identities.

A polynucleotide according to the invention can be joined to any of a variety of other
nucleotide sequences by well-established recombinant DNA techniques (see Sambrook J et al.
(1989) Molecular Cloning: A Laboratory Manual, Cold Spring Harbor Laboratory, NY). Useful
nucleotide sequences for joining to polypeptides include an assortment of vectors, e.g., plasmids,
15 cosmids, lambda phage derivatives, phagemids, and the like, that are well known in the art.
Accordingly, the invention also provides a vector including a polynucleotide of the invention
and a host cell containing the polynucleotide. In general, the vector contains an origin of
replication functional in at least one organism, convenient restriction endonuclease sites, and a
selectable marker for the host cell. Vectors according to the invention include expression
20 vectors, replication vectors, probe generation vectors, and sequencing vectors. A host cell
according to the invention can be a prokaryotic or eukaryotic cell and can be a unicellular
organism or part of a multicellular organism.

The sequences falling within the scope of the present invention are not limited to the
25 specific sequences herein described, but also include allelic variations thereof. Allelic variations
can be routinely determined by comparing the sequence provided in SEQ ID NOS:1, 2 or 5, a
representative fragment thereof, or a nucleotide sequence at least 99.9% identical to SEQ ID
NOS: 1, 2, or 5, with a sequence from another isolate of the same species. Furthermore, to
accommodate codon variability, the invention includes nucleic acid molecules coding for the
30 same amino acid sequences as do the specific ORFs disclosed herein. In other words, in the
coding region of an ORF, substitution of one codon for another which encodes the same amino
acid is expressly contemplated. Any specific sequence disclosed herein can be readily screened
for errors by resequencing a particular fragment, such as an ORF, in both directions (i.e.,

sequence both strands).

5 The present invention further provides recombinant constructs comprising a nucleic acid having the sequence of SEQ ID NOS:1, 2 or 5, or a fragment thereof. The recombinant constructs of the present invention comprise a vector, such as a plasmid or viral vector, into which a nucleic acid having the sequence of SEQ ID NOS:1, 2 or 5, or a fragment thereof is inserted, in a forward or reverse orientation. In the case of a vector comprising one of the ORFs
10 of the present invention, the vector may further comprise regulatory sequences, including for example, a promoter, operably linked to the ORF. For vectors comprising the EMFs and UMFs of the present invention, the vector may further comprise a marker sequence or heterologous ORF operably linked to the EMF or UMF. Large numbers of suitable vectors and promoters are known to those of skill in the art and are commercially available for generating the recombinant
15 constructs of the present invention. The following vectors are provided by way of example. Bacterial: pBs, phagescript, PsiX174, pBluescript SK, pBs KS, pNH8a, pNH16a, pNH18a, pNH46a (Stratagene); pTrc99A, pKK223-3, pKK233-3, pDR540, pRIT5 (Pharmacia). Eukaryotic: pWLneo, pSV2cat, pOG44, PXTI, pSG (Stratagene) pSVK3, pBPV, pMSG, pSVL (Pharmacia).

20 The isolated polynucleotide of the invention may be operably linked to an expression control sequence such as the pMT2 or pED expression vectors disclosed in Kaufman et al., Nucleic Acids Res. 19, 4485-4490 (1991), in order to produce the protein recombinantly. Many suitable expression control sequences are known in the art. General methods of expressing
25 recombinant proteins are also known and are exemplified in R. Kaufman, Methods in Enzymology 185, 537-566 (1990). As defined herein "operably linked" means that the isolated polynucleotide of the invention and an expression control sequence are situated within a vector or cell in such a way that the protein is expressed by a host cell which has been transformed (transfected) with the ligated polynucleotide/expression control sequence.

30 Promoter regions can be selected from any desired gene using CAT (chloramphenicol transferase) vectors or other vectors with selectable markers. Two appropriate vectors are pKK232-8 and pCM7. Particular named bacterial promoters include lacI, lacZ, T3, T7, gpt, lambda P_R, and trc. Eukaryotic promoters include CMV immediate early, HSV thymidine

kinase, early and late SV40, LTRs from retrovirus, and mouse metallothionein-I. Selection of
5 the appropriate vector and promoter is well within the level of ordinary skill in the art.
Generally, recombinant expression vectors will include origins of replication and selectable
markers permitting transformation of the host cell, e.g., the ampicillin resistance gene of *E. coli*
and *S. cerevisiae* TRP1 gene, and a promoter derived from a highly-expressed gene to direct
transcription of a downstream structural sequence. Such promoters can be derived from operons
10 encoding glycolytic enzymes such as 3-phosphoglycerate kinase (PGK), a-factor, acid
phosphatase, or heat shock proteins, among others. The heterologous structural sequence is
assembled in appropriate phase with translation initiation and termination sequences, and
preferably, a leader sequence capable of directing secretion of translated protein into the
periplasmic space or extracellular medium. Optionally, the heterologous sequence can encode a
15 fusion protein including an N-terminal identification peptide imparting desired characteristics,
e.g., stabilization or simplified purification of expressed recombinant product. Useful expression
vectors for bacterial use are constructed by inserting a structural DNA sequence encoding a
desired protein together with suitable translation initiation and termination signals in operable
reading phase with a functional promoter. The vector will comprise one or more phenotypic
20 selectable markers and an origin of replication to ensure maintenance of the vector and to, if
desirable, provide amplification within the host. Suitable prokaryotic hosts for transformation
include *E. coli*, *Bacillus subtilis*, *Salmonella typhimurium* and various species within the genera
Pseudomonas, *Streptomyces*, and *Staphylococcus*, although others may also be employed as a
25 matter of choice.

As a representative but non-limiting example, useful expression vectors for bacterial use
can comprise a selectable marker and bacterial origin of replication derived from commercially
available plasmids comprising genetic elements of the well known cloning vector pBR322
(ATCC 37017). Such commercial vectors include, for example, pKK223-3 (Pharmacia Fine
30 Chemicals, Uppsala, Sweden) and GEM 1 (Promega Biotec, Madison, WI, USA). These
pBR322 "backbone" sections are combined with an appropriate promoter and the structural
sequence to be expressed. Following transformation of a suitable host strain and growth of the
host strain to an appropriate cell density, the selected promoter is induced or derepressed by

appropriate means (e.g., temperature shift or chemical induction) and cells are cultured for an additional period. Cells are typically harvested by centrifugation, disrupted by physical or
5 chemical means, and the resulting crude extract retained for further purification.

Included within the scope of the nucleic acid sequences of the invention are nucleic acid sequences that hybridize under stringent conditions to a fragment of the DNA sequence in Figure 2 or 4 or its complement, which fragment is greater than about 10 bp, preferably 20-50 bp, and
10 even greater than 100 bp. In accordance with the invention, polynucleotide sequences which encode the novel nucleic acids, or functional equivalents thereof, may be used to generate recombinant DNA molecules that direct the expression of that nucleic acid, or a functional equivalent thereof, in appropriate host cells.

The nucleic acid sequences of the invention are further directed to sequences which
15 encode variants of the described nucleic acids. These amino acid sequence variants may be prepared by methods known in the art by introducing appropriate nucleotide changes into a native or variant polynucleotide. There are two variables in the construction of amino acid sequence variants: the location of the mutation and the nature of the mutation. The amino acid sequence variants of the nucleic acids are preferably constructed by mutating the polynucleotide
20 to give an amino acid sequence that does not occur in nature. These amino acid alterations can be made at sites that differ in the nucleic acids from different species (variable positions) or in highly conserved regions (constant regions). Sites at such locations will typically be modified in series, e.g., by substituting first with conservative choices (e.g., hydrophobic amino acid to a different hydrophobic amino acid) and then with more distant choices (e.g., hydrophobic amino
25 acid to a charged amino acid), and then deletions or insertions may be made at the target site. Amino acid sequence deletions generally range from about 1 to 30 residues, preferably about 1 to 10 residues, and are typically contiguous. Amino acid insertions include amino- and/or carboxyl-terminal fusions ranging in length from one to one hundred or more residues, as well as
30 intrasequence insertions of single or multiple amino acid residues. Intrasequence insertions may range generally from about 1 to 10 amino residues, preferably from 1 to 5 residues. Examples of terminal insertions include the heterologous signal sequences necessary for secretion or for intracellular targeting in different host cells.

In a preferred method, polynucleotides encoding the novel nucleic acids are changed via site-directed mutagenesis. This method uses oligonucleotide sequences that encode the polynucleotide sequence of the desired amino acid variant, as well as a sufficient adjacent nucleotide on both sides of the changed amino acid to form a stable duplex on either side of the site of being changed. In general, the techniques of site-directed mutagenesis are well known to those of skill in the art and this technique is exemplified by publications such as, Edelman *et al.*, DNA 2:183 (1983). A versatile and efficient method for producing site-specific changes in a polynucleotide sequence was published by Zoller and Smith, Nucleic Acids Res. 10:6487-6500 (1982). PCR may also be used to create amino acid sequence variants of the novel nucleic acids. When small amounts of template DNA are used as starting material, primer(s) that differs slightly in sequence from the corresponding region in the template DNA can generate the desired amino acid variant. PCR amplification results in a population of product DNA fragments that differ from the polynucleotide template encoding the polypeptide at the position specified by the primer. The product DNA fragments replace the corresponding region in the plasmid and this gives the desired amino acid variant.

A further technique for generating amino acid variants is the cassette mutagenesis technique described in Wells *et al.*, Gene 34:315 (1985); and other mutagenesis techniques well known in the art, such as, for example, the techniques in Sambrook *et al.*, supra, and Current Protocols in Molecular Biology, Ausubel *et al.* Due to the inherent degeneracy of the genetic code, other DNA sequences which encode substantially the same or a functionally equivalent amino acid sequence may be used in the practice of the invention for the cloning and expression of these novel nucleic acids. Such DNA sequences include those which are capable of hybridizing to the appropriate novel nucleic acid sequence under stringent conditions.

6.3. HOSTS

The present invention further provides host cells genetically engineered to contain the polynucleotides of the invention. For example, such host cells may contain nucleic acids of the invention introduced into the host cell using known transformation, transfection or infection methods. The present invention still further provides host cells genetically engineered to express

the polynucleotides of the invention, wherein such polynucleotides are in operative association
5 with a regulatory sequence heterologous to the host cell which drives expression of the
polynucleotides in the cell.

The host cell can be a higher eukaryotic host cell, such as a mammalian cell, a lower
eukaryotic host cell, such as a yeast cell, or the host cell can be a prokaryotic cell, such as a
bacterial cell. Introduction of the recombinant construct into the host cell can be effected by
10 calcium phosphate transfection, DEAE, dextran mediated transfection, or electroporation (Davis,
L. *et al.*, *Basic Methods in Molecular Biology* (1986)). The host cells containing one of
polynucleotides of the invention, can be used in conventional manners to produce the gene
product encoded by the isolated fragment (in the case of an ORF) or can be used to produce a
heterologous protein under the control of the EMF.

15 Any host/vector system can be used to express one or more of the ORFs of the present
invention. These include, but are not limited to, eukaryotic hosts such as HeLa cells, Cv-1 cell,
COS cells, and Sf9 cells, as well as prokaryotic host such as *E. coli* and *B. subtilis*. The most
preferred cells are those which do not normally express the particular polypeptide or protein or
which expresses the polypeptide or protein at low natural level. Mature proteins can be
20 expressed in mammalian cells, yeast, bacteria, or other cells under the control of appropriate
promoters. Cell-free translation systems can also be employed to produce such proteins using
RNAs derived from the DNA constructs of the present invention. Appropriate cloning and
expression vectors for use with prokaryotic and eukaryotic hosts are described by Sambrook, *et*
25 *al.*, in *Molecular Cloning: A Laboratory Manual*, Second Edition, Cold Spring Harbor, New
York (1989), the disclosure of which is hereby incorporated by reference.

Various mammalian cell culture systems can also be employed to express recombinant
protein. Examples of mammalian expression systems include the COS-7 lines of monkey kidney
fibroblasts, described by Gluzman, *Cell* 23:175 (1981), and other cell lines capable of expressing
30 a compatible vector, for example, the C127, 3T3, CHO, HeLa and BHK cell lines. Mammalian
expression vectors will comprise an origin of replication, a suitable promoter and also any
necessary ribosome binding sites, polyadenylation site, splice donor and acceptor sites,
transcriptional termination sequences, and 5' flanking nontranscribed sequences. DNA

sequences derived from the SV40 viral genome, for example, SV40 origin, early promoter, enhancer, splice, and polyadenylation sites may be used to provide the required nontranscribed
5 genetic elements. Recombinant polypeptides and proteins produced in bacterial culture are usually isolated by initial extraction from cell pellets, followed by one or more salting-out, aqueous ion exchange or size exclusion chromatography steps. Protein refolding steps can be used, as necessary, in completing configuration of the mature protein. Finally, high performance
10 liquid chromatography (HPLC) can be employed for final purification steps. Microbial cells employed in expression of proteins can be disrupted by any convenient method, including freeze-thaw cycling, sonication, mechanical disruption, or use of cell lysing agents.

A number of types of cells may act as suitable host cells for expression of the protein. Mammalian host cells include, for example, monkey COS cells, Chinese Hamster Ovary (CHO)
15 cells, human kidney 293 cells, human epidermal A431 cells, human Colo205 cells, 3T3 cells, CV-1 cells, other transformed primate cell lines, normal diploid cells, cell strains derived from in vitro culture of primary tissue, primary explants, HeLa cells, mouse L cells, BHK, HL-60, U937, HaK or Jurkat cells.

Alternatively, it may be possible to produce the protein in lower eukaryotes such as yeast
20 or in prokaryotes such as bacteria. Potentially suitable yeast strains include *Saccharomyces cerevisiae*, *Schizosaccharomyces pombe*, *Kluyveromyces* strains, *Candida*, or any yeast strain capable of expressing heterologous proteins. Potentially suitable bacterial strains include *Escherichia coli*, *Bacillus subtilis*, *Salmonella typhimurium*, or any bacterial strain capable of
25 expressing heterologous proteins. If the protein is made in yeast or bacteria, it may be necessary to modify the protein produced therein, for example by phosphorylation or glycosylation of the appropriate sites, in order to obtain the functional protein. Such covalent attachments may be accomplished using known chemical or enzymatic methods.

In another embodiment of the present invention, cells and tissues may be engineered to
30 express an endogenous gene comprising the polynucleotides of the invention under the control of inducible regulatory elements, in which case the regulatory sequences of the endogenous gene may be replaced by homologous recombination. As described herein, gene targeting can be used to replace a gene's existing regulatory region with a regulatory sequence isolated from a different

gene or a novel regulatory sequence synthesized by genetic engineering methods. Such
5 regulatory sequences may be comprised of promoters, enhancers, scaffold-attachment regions,
negative regulatory elements, transcriptional initiation sites, regulatory protein binding sites or
combinations of said sequences. Alternatively, sequences which affect the structure or stability
of the RNA or protein produced may be replaced, removed, added, or otherwise modified by
targeting, including polyadenylation signals. mRNA stability elements, splice sites, leader
10 sequences for enhancing or modifying transport or secretion properties of the protein, or other
sequences which alter or improve the function or stability of protein or RNA molecules.

The targeting event may be a simple insertion of the regulatory sequence, placing the
gene under the control of the new regulatory sequence, *e.g.*, inserting a new promoter or
enhancer or both upstream of a gene. Alternatively, the targeting event may be a simple deletion
15 of a regulatory element, such as the deletion of a tissue-specific negative regulatory element.
Alternatively, the targeting event may replace an existing element; for example, a tissue-specific
enhancer can be replaced by an enhancer that has broader or different cell-type specificity than
the naturally occurring elements. Here, the naturally occurring sequences are deleted and new
sequences are added. In all cases, the identification of the targeting event may be facilitated by
20 the use of one or more selectable marker genes that are contiguous with the targeting DNA,
allowing for the selection of cells in which the exogenous DNA has integrated into the host cell
genome. The identification of the targeting event may also be facilitated by the use of one or
more marker genes exhibiting the property of negative selection, such that the negatively
25 selectable marker is linked to the exogenous DNA, but configured such that the negatively
selectable marker flanks the targeting sequence, and such that a correct homologous
recombination event with sequences in the host cell genome does not result in the stable
integration of the negatively selectable marker. Markers useful for this purpose include the
Herpes Simplex Virus thymidine kinase (TK) gene or the bacterial xanthine-guanine
30 phosphoribosyl-transferase (gpt) gene.

The gene targeting or gene activation techniques which can be used in accordance with
this aspect of the invention are more particularly described in U.S. Patent No. 5,272,071 to
Chappel; U.S. Patent No. 5,578,461 to Sherwin et al.; International Application No.

PCT/US92/09627 (WO93/09222) by Selden et al.; and International Application No.

- 5 PCT/US90/06436 (WO91/06667) by Skoultchi et al., each of which is incorporated by reference herein in its entirety.

6.4. POLYPEPTIDES OF THE INVENTION

The isolated polypeptides of the invention include, but are not limited to, a polypeptide
10 comprising the amino acid sequence of SEQ ID NOS:3 or 6 or amino acid residues 1-502 of
SEQ ID NO: 4. The polypeptides of the invention further include polypeptides which comprise
one or more specific domains of the amino acid sequence in SEQ ID NOS:3 or 6 or amino acid
residues 1-502 of SEQ ID NO: 4. For example, but not limited to, a polypeptide comprising
amino acid residues 1 -21 of SEQ ID NO: 6; a polypeptide comprising amino acid residues 80-
15 93 of SEQ ID NO:6; a polypeptide comprising amino acid residues 95-128 of SEQ ID NO:6; a
polypeptide comprising amino acid residues 133-168 of SEQ ID NO:6; a polypeptide
comprising amino acid residues 175-214 of SEQ ID NO:6; a polypeptide comprising amino acid
residues 220-259 of SEQ ID NO:6; a polypeptide comprising amino acid residues 446-465 of
SEQ ID NO:6; or a polypeptide comprising amino acid residues 363-365 of SEQ ID NO:6.

20 The polypeptides of the present invention further include, but are not limited to, a
polypeptide comprising the amino acid sequence encoded by the cDNA insert of clone pEGFR-
HY1 deposited with the American Type Culture Collection (ATCC; 10801 University Blvd.,
Manassas, Virginia, 20110-2209, U.S.A.); a polypeptide comprising the amino acid encoded by
25 the cDNA insert of clone pEGFR-HY2 deposited with the ATCC (10801 University Blvd.,
Manassas, Virginia, 20110-2209, U.S.A.); a full length protein coding sequence of SEQ ID NO:
6 comprising the cDNA insert of clone pEGFR-HY2, nucleic acids 323-357 of SEQ ID NO: 5
and the cDNA insert of clone pEGFR-HY1; a mature protein coding sequence of SEQ ID NO: 6
comprising the cDNA insert of clone pEGFR-HY2, nucleic acids 323-357 of SEQ ID NO: 6 and
30 the cDNA insert of clone pEGFR-HY1.

Protein compositions of the present invention may further comprise an acceptable carrier,
such as a hydrophilic, e.g., pharmaceutically acceptable, carrier.

The invention also relates to methods for producing a polypeptide comprising growing a

culture of the cells of the invention in a suitable culture medium, and purifying the protein from the culture. For example, the methods of the invention include a process for producing a polypeptide in which a host cell containing a suitable expression vector that includes a polynucleotide of the invention is cultured under conditions that allow expression of the encoded polypeptide. The polypeptide can be recovered from the culture, conveniently from the culture medium, and further purified. Preferred embodiments include those in which the protein produced by such process is a full length or mature form of the protein.

The invention further provides a polypeptide including an amino acid sequence that is substantially equivalent to SEQ ID NOS:3 or 6 or amino acid residues 1-502 of SEQ ID NO:4. Polypeptides according to the invention can have at least about 95%, and more typically at least about 98%, sequence identity to SEQ ID NO:3 or 6 or amino acid residues 1-502 of SEQ ID NO: 4.

The present invention further provides isolated polypeptides encoded by the nucleic acid fragments of the present invention or by degenerate variants of the nucleic acid fragments of the present invention. By "degenerate variant" is intended nucleotide fragments which differ from a nucleic acid fragment of the present invention (e.g., an ORF) by nucleotide sequence but, due to the degeneracy of the genetic code, encode an identical polypeptide sequence. Preferred nucleic acid fragments of the present invention are the ORFs that encode proteins. A variety of methodologies known in the art can be utilized to obtain any one of the isolated polypeptides or proteins of the present invention. At the simplest level, the amino acid sequence can be synthesized using commercially available peptide synthesizers. This is particularly useful in producing small peptides and fragments of larger polypeptides. Fragments are useful, for example, in generating antibodies against the native polypeptide. In an alternative method, the polypeptide or protein is purified from bacterial cells which naturally produce the polypeptide or protein. One skilled in the art can readily follow known methods for isolating polypeptides and proteins in order to obtain one of the isolated polypeptides or proteins of the present invention.

These include, but are not limited to, immunochromatography, HPLC, size-exclusion chromatography, ion-exchange chromatography, and immuno-affinity chromatography. *See, e.g.,* Scopes, *Protein Purification: Principles and Practice*, Springer-Verlag (1994); Sambrook,

et al., in *Molecular Cloning: A Laboratory Manual*; Ausubel *et al.*, *Current Protocols in Molecular Biology*.

5 The polypeptides and proteins of the present invention can alternatively be purified from cells which have been altered to express the desired polypeptide or protein. As used herein, a cell is said to be altered to express a desired polypeptide or protein when the cell, through genetic manipulation, is made to produce a polypeptide or protein which it normally does not
10 produce or which the cell normally produces at a lower level. One skilled in the art can readily adapt procedures for introducing and expressing either recombinant or synthetic sequences into eukaryotic or prokaryotic cells in order to generate a cell which produces one of the polypeptides or proteins of the present invention. The purified polypeptides can be used in *in vitro* binding assays which are well known in the art to identify molecules which bind to the polypeptides.

15 These molecules include but are not limited to, for e.g., small molecules, molecules from combinatorial libraries, antibodies or other proteins. The molecules identified in the binding assay are then tested for antagonist or agonist activity in *in vivo* tissue culture or animal models that are well known in the art. In brief, the molecules are titrated into a plurality of cell cultures or animals and then tested for either cell/animal death or prolonged survival of the animal/cells.
20

In addition, the binding molecules may be complexed with toxins, e.g., ricin or cholera, or with other compounds that are toxic to cells. The toxin-binding molecule complex is then targeted to a tumor or other cell by the specificity of the binding molecule for SEQ ID NOS:3 or 6 or amino acid residues 1-502 of SEQ ID NO:4.

25 The protein of the invention may also be expressed as a product of transgenic animals, e.g., as a component of the milk of transgenic cows, goats, pigs, or sheep which are characterized by somatic or germ cells containing a nucleotide sequence encoding the protein.

The protein may also be produced by known conventional chemical synthesis. Methods for constructing the proteins of the present invention by synthetic means are known to those
30 skilled in the art. The synthetically-constructed protein sequences, by virtue of sharing primary, secondary or tertiary structural and/or conformational characteristics with proteins may possess biological properties in common therewith, including protein activity. Thus, they may be employed as biologically active or immunological substitutes for natural, purified proteins in

screening of therapeutic compounds and in immunological processes for the development of
5 antibodies.

The proteins provided herein also include proteins characterized by amino acid
sequences similar to those of purified proteins but into which modification are naturally
provided or deliberately engineered. For example, modifications in the peptide or DNA
sequences can be made by those skilled in the art using known techniques. Modifications of
10 interest in the protein sequences may include the alteration, substitution, replacement, insertion
or deletion of a selected amino acid residue in the coding sequence. For example, one or more of
the cysteine residues may be deleted or replaced with another amino acid to alter the
conformation of the molecule. Techniques for such alteration, substitution, replacement,
insertion or deletion are well known to those skilled in the art (see, e.g., U.S. Pat. No.
15 4,518,584). Preferably, such alteration, substitution, replacement, insertion or deletion retains the
desired activity of the protein.

Other fragments and derivatives of the sequences of proteins which would be expected to
retain protein activity in whole or in part and may thus be useful for screening or other
immunological methodologies may also be easily made by those skilled in the art given the
20 disclosures herein. Such modifications are believed to be encompassed by the present invention.

The protein may also be produced by operably linking the isolated polynucleotide of the
invention to suitable control sequences in one or more insect expression vectors, and employing
an insect expression system. Materials and methods for baculovirus/insect cell expression
25 systems are commercially available in kit form from, e.g., Invitrogen, San Diego, Calif., U.S.A.
(the MaxBat.RTM. kit), and such methods are well known in the art, as described in Summers
and Smith, Texas Agricultural Experiment Station Bulletin No. 1555 (1987), incorporated herein
by reference. As used herein, an insect cell capable of expressing a polynucleotide of the present
invention is "transformed."

30 The protein of the invention may be prepared by culturing transformed host cells under
culture conditions suitable to express the recombinant protein. The resulting expressed protein
may then be purified from such culture (i.e., from culture medium or cell extracts) using known
purification processes, such as gel filtration and ion exchange chromatography. The purification

of the protein may also include an affinity column containing agents which will bind to the protein; one or more column steps over such affinity resins as concanavalin A-agarose, heparin-
5 toyopearl.RTM. or Cibacrom blue 3GA Sepharose.RTM.; one or more steps involving hydrophobic interaction chromatography using such resins as phenyl ether, butyl ether, or propyl ether; or immunoaffinity chromatography.

Alternatively, the protein of the invention may also be expressed in a form which will
10 facilitate purification. For example, it may be expressed as a fusion protein, such as those of maltose binding protein (MBP), glutathione-S-transferase (GST) or thioredoxin (TRX). Kits for expression and purification of such fusion proteins are commercially available from New England BioLab (Beverly, Mass.), Pharmacia (Piscataway, N.J.) and In Vitrogen, respectively. The protein can also be tagged with an epitope and subsequently purified by using a specific
15 antibody directed to such epitope. One such epitope ("Flag") is commercially available from Kodak (New Haven, Conn.).

Finally, one or more reverse-phase high performance liquid chromatography (RP-HPLC) steps employing hydrophobic RP-HPLC media, e.g., silica gel having pendant methyl or other aliphatic groups, can be employed to further purify the protein. Some or all of the foregoing
20 purification steps, in various combinations, can also be employed to provide a substantially homogeneous isolated recombinant protein. The protein thus purified is substantially free of other mammalian proteins and is defined in accordance with the present invention as an "isolated protein."

25

6.4. DEPOSIT OF CLONES

The following clones, pEGFR-HY1 and pEGFR-HY2 were deposited with the American Type Culture Collection (ATCC) 10801 University Avenue, Manassas, Virginia, on November 19, 1998 under the terms of the Budapest Treaty. The cDNA insert of clone pEGFR-HY1
30 corresponds to nucleic acids 358-2365 of SEQ ID NO: 5, the vector containing the cDNA insert is pT7T3D-pac. The cDNA insert of pEGFR-HY2 corresponds to nucleic acids 1-322 of SEQ ID NO: 5. The vector containing the cDNA insert is pGEM®-T Easy Vector (Promega) with Marathon® cDNA Adaptor 2 Primer (Clontech) sequence attached to the 5' end. The clones

represent plasmid clones as described in the Examples set forth below.

Microorganism/Clone	ATCC Accession No.
pEGFR-HY1	---
pEGFR-HY2	---

6.5. USES AND BIOLOGICAL ACTIVITY

15 The polynucleotides and proteins of the present invention are expected to exhibit one or more of the uses or biological activities (including those associated with assays cited herein) identified below. Uses or activities described for proteins of the present invention may be provided by administration or use of such proteins or by administration or use of polynucleotides encoding such proteins (such as, for example, in gene therapies or vectors suitable for
20 introduction of DNA).

6.5.1. RESEARCH USES AND UTILITIES

The polynucleotides provided by the present invention can be used by the research community for various purposes. The polynucleotides can be used to express recombinant protein for analysis, characterization or therapeutic use; as markers for tissues in which the corresponding protein is preferentially expressed (either constitutively or at a particular stage of tissue differentiation or development or in disease states); as molecular weight markers on Southern gels; as chromosome markers or tags (when labeled) to identify chromosomes or to map related gene positions; to compare with endogenous DNA sequences in patients to identify potential genetic disorders; as probes to hybridize and thus discover novel, related DNA sequences; as a source of information to derive PCR primers for genetic fingerprinting; as a probe to "subtract-out" known sequences in the process of discovering other novel

polynucleotides; for selecting and making oligomers for attachment to a "gene chip" or other support, including for examination of expression patterns; to raise anti-protein antibodies using
5 DNA immunization techniques; and as an antigen to raise anti-DNA antibodies or elicit another immune response. Where the polynucleotide encodes a protein which binds or potentially binds to another protein (such as, for example, in a receptor-ligand interaction), the polynucleotide can also be used in interaction trap assays (such as, for example, that described in Gyuris et al., Cell
10 75:791-803 (1993)) to identify polynucleotides encoding the other protein with which binding occurs or to identify inhibitors of the binding interaction.

The proteins provided by the present invention can similarly be used in assay to determine biological activity, including in a panel of multiple proteins for high-throughput screening; to raise antibodies or to elicit another immune response; as a reagent (including the
15 labeled reagent) in assays designed to quantitatively determine levels of the protein (or its receptor) in biological fluids; as markers for tissues in which the corresponding protein is preferentially expressed (either constitutively or at a particular stage of tissue differentiation or development or in a disease state); and, of course, to isolate correlative receptors or ligands. Where the protein binds or potentially binds to another protein (such as, for example, in a
20 receptor-ligand interaction), the protein can be used to identify the other protein with which binding occurs or to identify inhibitors of the binding interaction. Proteins involved in these binding interactions can also be used to screen for peptide or small molecule inhibitors or agonists of the binding interaction.

25 Any or all of these research utilities are capable of being developed into reagent grade or kit format for commercialization as research products.

Methods for performing the uses listed above are well known to those skilled in the art. References disclosing such methods include without limitation "Molecular Cloning: A Laboratory Manual", 2d ed., Cold Spring Harbor Laboratory Press, Sambrook, J., E. F. Fritsch
30 and T. Maniatis eds., 1989, and "Methods in Enzymology: Guide to Molecular Cloning Techniques", Academic Press, Berger, S. L. and A. R. Kimmel eds., 1987.

5

6.5.2. NUTRITIONAL USES

Polynucleotides and proteins of the present invention can also be used as nutritional sources or supplements. Such uses include without limitation use as a protein or amino acid supplement, use as a carbon source, use as a nitrogen source and use as a source of carbohydrate. In such cases the protein or polynucleotide of the invention can be added to the feed of a particular organism or can be administered as a separate solid or liquid preparation, such as in the form of powder, pills, solutions, suspensions or capsules. In the case of microorganisms, the protein or polynucleotide of the invention can be added to the medium in or on which the microorganism is cultured.

15

6.5.3. CYTOKINE AND CELL PROLIFERATION/ DIFFERENTIATION ACTIVITY

A protein of the present invention may exhibit cytokine, cell proliferation (either inducing or inhibiting) or cell differentiation (either inducing or inhibiting) activity or may induce production of other cytokines in certain cell populations. A polynucleotide of the invention can encode a polypeptide exhibiting such attributes. Many protein factors discovered to date, including all known cytokines, have exhibited activity in one or more factor-dependent cell proliferation assays, and hence the assays serve as a convenient confirmation of cytokine activity. The activity of a protein of the present invention is evidenced by any one of a number of routine factor dependent cell proliferation assays for cell lines including, without limitation, 32D, DA2, DA1G, T10, B9, B9/11, BaF3, MC9/G, M+(preB M+), 2E8, RB5, DA1, 123, T1165, HT2, CTLL2, TF-1, Mo7e and CMK. The activity of a protein of the invention may, among other means, be measured by the following methods:

Assays for T-cell or thymocyte proliferation include without limitation those described in: Current Protocols in Immunology, Ed by J. E. Coligan, A. M. Kruisbeek, D. H. Margulies, E. M. Shevach, W. Strober, Pub. Greene Publishing Associates and Wiley-Interscience (Chapter 3, In Vitro assays for Mouse Lymphocyte Function 3.1-3.19; Chapter 7, Immunologic studies in Humans); Takai et al., J. Immunol. 137:3494-3500, 1986; Bertagnolli et al., J. Immunol.

145:1706-1712, 1990; Bertagnolli et al., Cellular Immunology 133:327-341, 1991; Bertagnolli,
5 et al., I. Immunol. 149:3778-3783, 1992; Bowman et al., I. Immunol. 152:1756-1761, 1994.

Assays for cytokine production and/or proliferation of spleen cells, lymph node cells or
thymocytes include, without limitation, those described in: Polyclonal T cell stimulation,
Kruisbeek, A. M. and Shevach, E. M. In Current Protocols in Immunology. J. E. e.a. Coligan
eds. Vol 1 pp. 3.12.1-3.12.14, John Wiley and Sons, Toronto. 1994; and Measurement of mouse
10 and human interleukin .gamma., Schreiber, R. D. In Current Protocols in Immunology. J. E. e.a.
Coligan eds. Vol 1 pp. 6.8.1-6.8.8, John Wiley and Sons, Toronto. 1994.

Assays for proliferation and differentiation of hematopoietic and lymphopoietic cells
include, without limitation, those described in: Measurement of Human and Murine Interleukin
2 and Interleukin 4, Bottomly, K., Davis, L. S. and Lipsky, P. E. In Current Protocols in
15 Immunology. J. E. e.a. Coligan eds. Vol 1 pp. 6.3.1-6.3.12, John Wiley and Sons, Toronto.
1991; deVries et al., J. Exp. Med. 173:1205-1211, 1991; Moreau et al., Nature 336:690-692,
1988; Greenberger et al., Proc. Natl. Acad. Sci. U.S.A. 80:2931-2938, 1983; Measurement of
mouse and human interleukin 6--Nordan, R. In Current Protocols in Immunology. J. E. e.a.
Coligan eds. Vol 1 pp. 6.6.1-6.6.5, John Wiley and Sons, Toronto. 1991; Smith et al., Proc. Natl.
20 Aced. Sci. U.S.A. 83:1857-1861, 1986; Measurement of human Interleukin 11--Bennett, F.,
Giannotti, J., Clark, S. C. and Turner, K. J. In Current Protocols in Immunology. J. E. e.a.
Coligan eds. Vol 1 pp. 6.15.1 John Wiley and Sons, Toronto. 1991; Measurement of mouse and
human Interleukin 9--Ciarletta, A., Giannotti, J., Clark, S. C. and Turner, K. J. In Current
25 Protocols in Immunology. J. E. e.a. Coligan eds. Vol 1 pp. 6.13.1, John Wiley and Sons,
Toronto. 1991.

Assays for T-cell clone responses to antigens (which will identify, among others,
proteins that affect APC-T cell interactions as well as direct T-cell effects by measuring
proliferation and cytokine production) include, without limitation, those described in: Current
30 Protocols in Immunology, Ed by J. E. Coligan, A. M. Kruisbeek, D. H. Margulies, E. M.
Shevach, W Strober, Pub. Greene Publishing Associates and Wiley-Interscience (Chapter 3, In
Vitro assays for Mouse Lymphocyte Function; Chapter 6, Cytokines and their cellular receptors;
Chapter 7, Immunologic studies in Humans); Weinberger et al., Proc. Natl. Acad. Sci. USA

77:6091-6095, 1980; Weinberger et al., Eur. J. Immun. 11:405-411, 1981; Takai et al., J. Immunol. 137:3494-3500, 1986; Takai et al., J. Immunol. 140:508-512, 1988.

6.5.4. IMMUNE STIMULATING OR SUPPRESSING ACTIVITY

A protein of the present invention may also exhibit immune stimulating or immune suppressing activity, including without limitation the activities for which assays are described herein. A polynucleotide of the invention can encode a polypeptide exhibiting such activities. A protein may be useful in the treatment of various immune deficiencies and disorders (including severe combined immunodeficiency (SCID)), e.g., in regulating (up or down) growth and proliferation of T and/or B lymphocytes, as well as effecting the cytolytic activity of NK cells and other cell populations. These immune deficiencies may be genetic or be caused by viral (e.g., HIV) as well as bacterial or fungal infections, or may result from autoimmune disorders. More specifically, infectious diseases caused by viral, bacterial, fungal or other infection may be treatable using a protein of the present invention, including infections by HIV, hepatitis viruses, herpesviruses, mycobacteria, Leishmania spp., malaria spp. and various fungal infections such as candidiasis. Of course, in this regard, a protein of the present invention may also be useful where a boost to the immune system generally may be desirable, i.e., in the treatment of cancer.

Autoimmune disorders which may be treated using a protein of the present invention include, for example, connective tissue disease, multiple sclerosis, systemic lupus erythematosus, rheumatoid arthritis, autoimmune pulmonary inflammation, Guillain-Barre syndrome, autoimmune thyroiditis, insulin dependent diabetes mellitus, myasthenia gravis, graft-versus-host disease and autoimmune inflammatory eye disease. Such a protein of the present invention may also be useful in the treatment of allergic reactions and conditions, such as asthma (particularly allergic asthma) or other respiratory problems. Other conditions, in which immune suppression is desired (including, for example, organ transplantation), may also be treatable using a protein of the present invention.

Using the proteins of the invention it may also be possible to immune responses, in a number of ways. Down regulation may be in the form of inhibiting or blocking an immune response already in progress or may involve preventing the induction of an immune response.

The functions of activated T cells may be inhibited by suppressing T cell responses or by inducing specific tolerance in T cells, or both. Immunosuppression of T cell responses is generally an active, non-antigen-specific, process which requires continuous exposure of the T cells to the suppressive agent. Tolerance, which involves inducing non-responsiveness or anergy in T cells, is distinguishable from immunosuppression in that it is generally antigen-specific and persists after exposure to the tolerizing agent has ceased. Operationally, tolerance can be demonstrated by the lack of a T cell response upon reexposure to specific antigen in the absence of the tolerizing agent.

Down regulating or preventing one or more antigen functions (including without limitation B lymphocyte antigen functions (such as, for example, B7)), e.g., preventing high level lymphokine synthesis by activated T cells, will be useful in situations of tissue, skin and organ transplantation and in graft-versus-host disease (GVHD). For example, blockage of T cell function should result in reduced tissue destruction in tissue transplantation. Typically, in tissue transplants, rejection of the transplant is initiated through its recognition as foreign by T cells, followed by an immune reaction that destroys the transplant. The administration of a molecule which inhibits or blocks interaction of a B7 lymphocyte antigen with its natural ligand(s) on immune cells (such as a soluble, monomeric form of a peptide having B7-2 activity alone or in conjunction with a monomeric form of a peptide having an activity of another B lymphocyte antigen (e.g., B7-1, B7-3) or blocking antibody), prior to transplantation can lead to the binding of the molecule to the natural ligand(s) on the immune cells without transmitting the corresponding costimulatory signal. Blocking B lymphocyte antigen function in this matter prevents cytokine synthesis by immune cells, such as T cells, and thus acts as an immunosuppressant. Moreover, the lack of costimulation may also be sufficient to anergize the T cells, thereby inducing tolerance in a subject. Induction of long-term tolerance by B lymphocyte antigen-blocking reagents may avoid the necessity of repeated administration of these blocking reagents. To achieve sufficient immunosuppression or tolerance in a subject, it may also be necessary to block the function of a combination of B lymphocyte antigens.

The efficacy of particular blocking reagents in preventing organ transplant rejection or GVHD can be assessed using animal models that are predictive of efficacy in humans. Examples

of appropriate systems which can be used include allogeneic cardiac grafts in rats and
5 xenogeneic pancreatic islet cell grafts in mice, both of which have been used to examine the
immunosuppressive effects of CTLA4Ig fusion proteins in vivo as described in Lenschow et al.,
Science 257:789-792 (1992) and Turka et al., Proc. Natl. Acad. Sci USA, 89:11102-11105
(1992). In addition, murine models of GVHD (see Paul ed., Fundamental Immunology, Raven
Press, New York, 1989, pp. 846-847) can be used to determine the effect of blocking B
10 lymphocyte antigen function in vivo on the development of that disease.

Blocking antigen function may also be therapeutically useful for treating autoimmune
diseases. Many autoimmune disorders are the result of inappropriate activation of T cells that are
reactive against self tissue and which promote the production of cytokines and autoantibodies
involved in the pathology of the diseases. Preventing the activation of autoreactive T cells may
15 reduce or eliminate disease symptoms. Administration of reagents which block costimulation of
T cells by disrupting receptor:ligand interactions of B lymphocyte antigens can be used to inhibit
T cell activation and prevent production of autoantibodies or T cell-derived cytokines which
may be involved in the disease process. Additionally, blocking reagents may induce antigen-
specific tolerance of autoreactive T cells which could lead to long-term relief from the disease.
20 The efficacy of blocking reagents in preventing or alleviating autoimmune disorders can be
determined using a number of well-characterized animal models of human autoimmune diseases.
Examples include murine experimental autoimmune encephalitis, systemic lupus erythematosus in
MRL/lpr/lpr mice or NZB hybrid mice, murine autoimmune collagen arthritis, diabetes mellitus
in NOD mice and BB rats, and murine experimental myasthenia gravis (see Paul ed.,
25 Fundamental Immunology, Raven Press, New York, 1989, pp. 840-856).

Upregulation of an antigen function (preferably a B lymphocyte antigen function), as a
means of up regulating immune responses, may also be useful in therapy. Upregulation of
immune responses may be in the form of enhancing an existing immune response or eliciting an
30 initial immune response. For example, enhancing an immune response through stimulating B
lymphocyte antigen function may be useful in cases of viral infection. In addition, systemic viral
diseases such as influenza, the common cold, and encephalitis might be alleviated by the
administration of stimulatory forms of B lymphocyte antigens systemically.

Alternatively, anti-vital immune responses may be enhanced in an infected patient by removing T cells from the patient, costimulating the T cells in vitro with viral antigen-pulsed APCs either expressing a peptide of the present invention or together with a stimulatory form of a soluble peptide of the present invention and reintroducing the in vitro activated T cells into the patient. Another method of enhancing anti-viral immune responses would be to isolate infected cells from a patient, transfect them with a nucleic acid encoding a protein of the present invention as described herein such that the cells express all or a portion of the protein on their surface, and reintroduce the transfected cells into the patient. The infected cells would now be capable of delivering a costimulatory signal to, and thereby activate, T cells in vivo.

The presence of the peptide of the present invention having the activity of a B lymphocyte antigen(s) on the surface of the tumor cell provides the necessary costimulation signal to T cells to induce a T cell mediated immune response against the transfected tumor cells. In addition, tumor cells which lack MHC class I or MHC class II molecules, or which fail to reexpress sufficient mounts of MHC class I or MHC class II molecules, can be transfected with nucleic acid encoding all or a portion of (e.g., a cytoplasmic-domain truncated portion) of an MHC class I α .alpha. chain protein and .beta..sub.2 microglobulin protein or an MHC class II .alpha. chain protein and an MHC class II .beta. chain protein to thereby express MHC class I or MHC class II proteins on the cell surface. Expression of the appropriate class I or class II MHC in conjunction with a peptide having the activity of a B lymphocyte antigen (e.g., B7-1, B7-2, B7-3) induces a T cell mediated immune response against the transfected tumor cell. Optionally, a gene encoding an antisense construct which blocks expression of an MHC class II associated protein, such as the invariant chain, can also be cotransfected with a DNA encoding a peptide having the activity of a B lymphocyte antigen to promote presentation of tumor associated antigens and induce tumor specific immunity. Thus, the induction of a T cell mediated immune response in a human subject may be sufficient to overcome tumor-specific tolerance in the subject.

The activity of a protein of the invention may, among other means, be measured by the following methods:

Suitable assays for thymocyte or splenocyte cytotoxicity include, without limitation,

- those described in: Current Protocols in Immunology, Ed by J. E. Coligan, A. M. Kruisbeek, D. H. Margulies, E. M. Shevach, W. Strober, Pub. Greene Publishing Associates and Wiley-Interscience (Chapter 3, In Vitro assays for Mouse Lymphocyte Function 3.1-3.19; Chapter 7, Immunologic studies in Humans); Herrmann et al., Proc. Natl. Acad. Sci. USA 78:2488-2492, 1981; Herrmann et al., J. Immunol. 128:1968-1974, 1982; Handa et al., J. Immunol. 135:1564-1572, 1985; Takai et al., J. Immunol. 137:3494-3500, 1986; Takai et al., J. Immunol. 140:508-512, 1988; Herrmann et al., Proc. Natl. Acad. Sci. USA 78:2488-2492, 1981; Herrmann et al., J. Immunol. 128:1968-1974, 1982; Handa et al., J. Immunol. 135:1564-1572, 1985; Takai et al., J. Immunol. 137:3494-3500, 1986; Bowman et al., J. Virology 61:1992-1998; Takai et al., J. Immunol. 140:508-512, 1988; Bertagnolli et al., Cellular Immunology 133:327-341, 1991; Brown et al., J. Immunol. 153:3079-3092, 1994.
- 15 Assays for T-cell-dependent immunoglobulin responses and isotype switching (which will identify, among others, proteins that modulate T-cell dependent antibody responses and that affect Th1/Th2 profiles) include, without limitation, those described in: Maliszewski, J. Immunol. 144:3028-3033, 1990; and Assays for B cell function: In vitro antibody production, Mond, J. J. and Brunswick, M. In Current Protocols in Immunology. J. E. e.a. Coligan eds. Vol 1 pp. 3.8.1-3.8.16, John Wiley and Sons, Toronto. 1994.
- 20 Mixed lymphocyte reaction (MLR) assays (which will identify, among others, proteins that generate predominantly Th1 and CTL responses) include, without limitation, those described in: Current Protocols in Immunology, Ed by J. E. Coligan, A. M. Kruisbeek, D. H. Margulies, E. M. Shevach, W. Strober, Pub. Greene Publishing Associates and Wiley-Interscience (Chapter 3, In Vitro assays for Mouse Lymphocyte Function 3.1-3.19; Chapter 7, Immunologic studies in Humans); Takai et al., J. Immunol. 137:3494-3500, 1986; Takai et al., J. Immunol. 140:508-512, 1988; Bertagnolli et al., J. Immunol. 149:3778-3783, 1992.
- 25 Dendritic cell-dependent assays (which will identify, among others, proteins expressed by dendritic cells that activate naive T-cells) include, without limitation, those described in: Guery et al., J. Immunol. 134:536-544, 1995; Inaba et al., Journal of Experimental Medicine 173:549-559, 1991; Macatonia et al., Journal of Immunology 154:5071-5079, 1995; Porgador et al., Journal of Experimental Medicine 182:255-260, 1995; Nair et al., Journal of Virology

67:4062-4069, 1993; Huang et al., Science 264:961-965, 1994; Macatonia et al., Journal of
5 Experimental Medicine 169:1255-1264, 1989; Bhardwaj et al., Journal of Clinical Investigation
94:797-807, 1994; and Inaba et al., Journal of Experimental Medicine 172:631-640, 1990.

Assays for lymphocyte survival/apoptosis (which will identify, among others, proteins
that prevent apoptosis after superantigen induction and proteins that regulate lymphocyte
homeostasis) include, without limitation, those described in: Darzynkiewicz et al., Cytometry
10 13:795-808, 1992; Gorczyca et al., Leukemia 7:659-670, 1993; Gorczyca et al., Cancer Research
53:1945-1951, 1993; Itoh et al., Cell 66:233-243, 1991; Zacharchuk, Journal of Immunology
145:4037-4045, 1990; Zamai et al., Cytometry 14:891-897, 1993; Gorczyca et al., International
Journal of Oncology 1:639-648, 1992.

Assays for proteins that influence early steps of T-cell commitment and development
15 include, without limitation, those described in: Antica et al., Blood 84:111-117, 1994; Fine et al.,
Cellular Immunology 155:111-122, 1994; Galy et al., Blood 85:2770-2778, 1995; Toki et al.,
Proc. Nat. Acad. Sci. USA 88:7548-7551, 1991.

20 6.5.5. HEMATOPOIESIS REGULATING ACTIVITY

A protein of the present invention may be useful in regulation of hematopoiesis and,
consequently, in the treatment of myeloid or lymphoid cell deficiencies. Even marginal
biological activity in support of colony forming cells or of factor-dependent cell lines indicates
involvement in regulating hematopoiesis, e.g. in supporting the growth and proliferation of
25 erythroid progenitor cells alone or in combination with other cytokines, thereby indicating
utility, for example, in treating various anemias or for use in conjunction with
irradiation/chemotherapy to stimulate the production of erythroid precursors and/or erythroid
cells; in supporting the growth and proliferation of myeloid cells such as granulocytes and
monocytes/macrophages (i.e., traditional CSF activity) useful, for example, in conjunction with
30 chemotherapy to prevent or treat consequent myelo-suppression; in supporting the growth and
proliferation of megakaryocytes and consequently of platelets thereby allowing prevention or
treatment of various platelet disorders such as thrombocytopenia, and generally for use in place
of or complimentary to platelet transfusions; and/or in supporting the growth and proliferation of

hematopoietic stem cells which are capable of maturing to any and all of the above-mentioned
5 hematopoietic cells and therefore find therapeutic utility in various stem cell disorders (such as
those usually treated with transplantation, including, without limitation, aplastic anemia and
paroxysmal nocturnal hemoglobinuria), as well as in repopulating the stem cell compartment
post irradiation/chemotherapy, either in-vivo or ex-vivo (i.e., in conjunction with bone marrow
transplantation or with peripheral progenitor cell transplantation (homologous or heterologous))
10 as normal cells or genetically manipulated for gene therapy.

The activity of a protein of the invention may, among other means, be measured by the
following methods:

Suitable assays for proliferation and differentiation of various hematopoietic lines are
cited above.

15 Assays for embryonic stem cell differentiation (which will identify, among others,
proteins that influence embryonic differentiation hematopoiesis) include, without limitation,
those described in: Johansson et al. *Cellular Biology* 15:141-151, 1995; Keller et al., *Molecular
and Cellular Biology* 13:473-486, 1993; McClanahan et al., *Blood* 81:2903-2915, 1993.

20 Assays for stem cell survival and differentiation (which will identify, among others,
proteins that regulate lympho-hematopoiesis) include, without limitation, those described in:
Methylcellulose colony forming assays, Freshney, M. G. In *Culture of Hematopoietic Cells*. R. I.
Freshney, et al. eds. Vol pp. 265-268, Wiley-Liss, Inc., New York, N.Y. 1994; Hirayama et al.,
Proc. Natl. Acad. Sci. USA 89:5907-5911, 1992; Primitive hematopoietic colony forming cells
25 with high proliferative potential, McNiece, I. K. and Briddell, R. A. In *Culture of Hematopoietic
Cells*. R. I. Freshney, et al. eds. Vol pp. 23-39, Wiley-Liss, Inc., New York, N.Y. 1994; Neben et
al., *Experimental Hematology* 22:353-359, 1994; Cobblestone area forming cell assay,
Ploemacher, R. E. In *Culture of Hematopoietic Cells*. R. I. Freshney, et al. eds. Vol pp. 1-21,
Wiley-Liss, Inc., New York, N.Y. 1994; Long term bone marrow cultures in the presence of
30 stromal cells, Spooncer, E., Dexter, M. and Allen, T. In *Culture of Hematopoietic Cells*. R. I.
Freshney, et al. eds. Vol pp. 163-179, Wiley-Liss, Inc., New York, N.Y. 1994; Long term
culture initiating cell assay, Sutherland, H. J. In *Culture of Hematopoietic Cells*. R. I. Freshney,
et al. eds. Vol pp. 139-162, Wiley-Liss, Inc., New York, N.Y. 1994.

5 **6.5.6. TISSUE GROWTH ACTIVITY**

A protein of the present invention also may have utility in compositions used for bone, cartilage, tendon, ligament and/or nerve tissue growth or regeneration, as well as for wound healing and tissue repair and replacement, and in the treatment of burns, incisions and ulcers.

A protein of the present invention, which induces cartilage and/or bone growth in
10 circumstances where bone is not normally formed, has application in the healing of bone fractures and cartilage damage or defects in humans and other animals. Such a preparation employing a protein of the invention may have prophylactic use in closed as well as open fracture reduction and also in the improved fixation of artificial joints. De novo bone formation induced by an osteogenic agent contributes to the repair of congenital, trauma induced, or
15 oncologic resection induced craniofacial defects, and also is useful in cosmetic plastic surgery.

A protein of this invention may also be used in the treatment of periodontal disease, and in other tooth repair processes. Such agents may provide an environment to attract bone-forming cells, stimulate growth of bone-forming cells or induce differentiation of progenitors of bone-forming cells. A protein of the invention may also be useful in the treatment of osteoporosis or
20 osteoarthritis, such as through stimulation of bone and/or cartilage repair or by blocking inflammation or processes of tissue destruction (collagenase activity, osteoclast activity, etc.) mediated by inflammatory processes.

Another category of tissue regeneration activity that may be attributable to the protein of
25 the present invention is tendon/ligament formation. A protein of the present invention, which induces tendon/ligament-like tissue or other tissue formation in circumstances where such tissue is not normally formed, has application in the healing of tendon or ligament tears, deformities and other tendon or ligament defects in humans and other animals. Such a preparation employing a tendon/ligament-like tissue inducing protein may have prophylactic use in
30 preventing damage to tendon or ligament tissue, as well as use in the improved fixation of tendon or ligament to bone or other tissues, and in repairing defects to tendon or ligament tissue. De novo tendon/ligament-like tissue formation induced by a composition of the present invention contributes to the repair of congenital, trauma induced, or other tendon or ligament

defects of other origin, and is also useful in cosmetic plastic surgery for attachment or repair of
5 tendons or ligaments. The compositions of the present invention may provide environment to
attract tendon- or ligament-forming cells, stimulate growth of tendon- or ligament-forming cells,
induce differentiation of progenitors of tendon- or ligament-forming cells, or induce growth of
tendon/ligament cells or progenitors ex vivo for return in vivo to effect tissue repair. The
compositions of the invention may also be useful in the treatment of tendinitis, carpal tunnel
10 syndrome and other tendon or ligament defects. The compositions may also include an
appropriate matrix and/or sequestering agent as a carrier as is well known in the art.

The protein of the present invention may also be useful for proliferation of neural cells
and for regeneration of nerve and brain tissue, i.e. for the treatment of central and peripheral
nervous system diseases and neuropathies, as well as mechanical and traumatic disorders, which
15 involve degeneration, death or trauma to neural cells or nerve tissue. More specifically, a protein
may be used in the treatment of diseases of the peripheral nervous system, such as peripheral
nerve injuries, peripheral neuropathy and localized neuropathies, and central nervous system
diseases, such as Alzheimer's, Parkinson's disease, Huntington's disease, amyotrophic lateral
sclerosis, and Shy-Drager syndrome. Further conditions which may be treated in accordance
20 with the present invention include mechanical and traumatic disorders, such as spinal cord
disorders, head trauma and cerebrovascular diseases such as stroke. Peripheral neuropathies
resulting from chemotherapy or other medical therapies may also be treatable using a protein of
the invention.

25 Proteins of the invention may also be useful to promote better or faster closure of non-
healing wounds, including without limitation pressure ulcers, ulcers associated with vascular
insufficiency, surgical and traumatic wounds, and the like.

It is expected that a protein of the present invention may also exhibit activity for
generation or regeneration of other tissues, such as organs (including, for example, pancreas,
30 liver, intestine, kidney, skin, endothelium), muscle (smooth, skeletal or cardiac) and vascular
(including vascular endothelium) tissue, or for promoting the growth of cells comprising such
tissues. Part of the desired effects may be by inhibition or modulation of fibrotic scarring to
allow normal tissue to regenerate. A protein of the invention may also exhibit angiogenic

activity.

5 A protein of the present invention may also be useful for gut protection or regeneration and treatment of lung or liver fibrosis, reperfusion injury in various tissues, and conditions resulting from systemic cytokine damage.

A protein of the present invention may also be useful for promoting or inhibiting differentiation of tissues described above from precursor tissues or cells; or for inhibiting the
10 growth of tissues described above.

The activity of a protein of the invention may, among other means, be measured by the following methods:

Assays for tissue generation activity include, without limitation, those described in: International Patent Publication No. WO95/16035 (bone, cartilage, tendon); International Patent
15 Publication No. WO95/05846 (nerve, neuronal); International Patent Publication No. WO91/07491 (skin, endothelium).

Assays for wound healing activity include, without limitation, those described in: Winter, Epidermal Wound Healing, pps. 71-112 (Maibach, H. I. and Rovee, D. T., eds.), Year Book Medical Publishers, Inc., Chicago, as modified by Eaglstein and Mertz, J. Invest. Dermatol
20 71:382-84 (1978).

6.5.7. ACTIVIN/INHIBIN ACTIVITY

A protein of the present invention may also exhibit activin- or inhibin-related
25 activities. A polynucleotide of the invention may encode a polypeptide exhibiting such characteristics. Inhibins are characterized by their ability to inhibit the release of follicle stimulating hormone (FSH), while activins are characterized by their ability to stimulate the release of follicle stimulating hormone (FSH). Thus, a protein of the present invention, alone or in heterodimers with a member of the inhibin α -family, may be useful as a contraceptive based
30 on the ability of inhibins to decrease fertility in female mammals and decrease spermatogenesis in male mammals. Administration of sufficient amounts of other inhibins can induce infertility in these mammals. Alternatively, the protein of the invention, as a homodimer or as a heterodimer with other protein subunits of the inhibin- β group, may be useful as a fertility

inducing therapeutic, based upon the ability of activin molecules in stimulating FSH release
5 from cells of the anterior pituitary. See, for example, U.S. Pat. No. 4,798,885. A protein of the
invention may also be useful for advancement of the onset of fertility in sexually immature
mammals, so as to increase the lifetime reproductive performance of domestic animals such as
cows, sheep and pigs.

The activity of a protein of the invention may, among other means, be measured by the
10 following methods:

Assays for activin/inhibin activity include, without limitation, those described in: Vale et
al., Endocrinology 91:562-572, 1972; Ling et al., Nature 321:779-782, 1986; Vale et al., Nature
321:776-779, 1986; Mason et al., Nature 318:659-663, 1985; Forage et al., Proc. Natl. Acad. Sci.
USA 83:3091-3095, 1986.

15

6.5.8. CHEMOTACTIC/CHEMOKINETIC ACTIVITY

A protein of the present invention may have chemotactic or chemokinetic activity (e.g.,
act as a chemokine) for mammalian cells, including, for example, monocytes, fibroblasts,
neutrophils, T-cells, mast cells, eosinophils, epithelial and/or endothelial cells. A polynucleotide
20 of the invention can encode a polypeptide exhibiting such attributes. Chemotactic and
chemokinetic proteins can be used to mobilize or attract a desired cell population to a desired
site of action. Chemotactic or chemokinetic proteins provide particular advantages in treatment
of wounds and other trauma to tissues, as well as in treatment of localized infections. For
example, attraction of lymphocytes, monocytes or neutrophils to tumors or sites of infection may
25 result in improved immune responses against the tumor or infecting agent.

A protein or peptide has chemotactic activity for a particular cell population if it can
stimulate, directly or indirectly, the directed orientation or movement of such cell population.
Preferably, the protein or peptide has the ability to directly stimulate directed movement of cells.
30 Whether a particular protein has chemotactic activity for a population of cells can be readily
determined by employing such protein or peptide in any known assay for cell chemotaxis.

The activity of a protein of the invention may, among other means, be measured by the
following methods:

Assays for chemotactic activity (which will identify proteins that induce or prevent
5 chemotaxis) consist of assays that measure the ability of a protein to induce the migration of
cells across a membrane as well as the ability of a protein to induce the adhesion of one cell
population to another cell population. Suitable assays for movement and adhesion include,
without limitation, those described in: Current Protocols in Immunology, Ed by J. E. Coligan, A.
M. Kruisbeek, D. H. Marguiles, E. M. Shevach, W. Strober, Pub. Greene Publishing Associates
10 and Wiley-Interscience (Chapter 6.12, Measurement of alpha and beta Chemokines 6.12.1-
6.12.28; Taub et al. J. Clin. Invest. 95:1370-1376, 1995; Lind et al. APMIS 103:140-146, 1995;
Muller et al Eur. J. Immunol. 25:1744-1748; Gruber et al. J. of Immunol. 152:5860-5867, 1994;
Johnston et al. J. of Immunol. 153:1762-1768, 1994.

15

6.5.9. HEMOSTATIC AND THROMBOLYTIC ACTIVITY

A protein of the invention may also exhibit hemostatic or thrombolytic activity. A
polynucleotide of the invention can encode a polypeptide exhibiting such attributes. Such a
protein is expected to be useful in treatment of various coagulation disorders (including
hereditary disorders, such as hemophilias) or to enhance coagulation and other hemostatic events
20 in treating wounds resulting from trauma, surgery or other causes. A protein of the invention
may also be useful for dissolving or inhibiting formation of thromboses and for treatment and
prevention of conditions resulting therefrom (such as, for example, infarction of cardiac and
central nervous system vessels (e.g., stroke).

25 The activity of a protein of the invention may, among other means, be measured by the
following methods:

Assay for hemostatic and thrombolytic activity include, without limitation, those
described in: Linet et al., J. Clin. Pharmacol. 26:131-140, 1986; Burdick et al., Thrombosis Res.
45:413-419, 1987; Humphrey et al., Fibrinolysis 5:71-79 (1991); Schaub, Prostaglandins
30 35:467-474, 1988.

6.5.10. RECEPTOR/LIGAND ACTIVITY

A protein of the present invention may also demonstrate activity as receptors, receptor

ligands or inhibitors or agonists of receptor/ligand interactions. A polynucleotide of the
5 invention can encode a polypeptide exhibiting such characteristics. Examples of such receptors
and ligands include, without limitation, cytokine receptors and their ligands, receptor kinases
and their ligands, receptor phosphatases and their ligands, receptors involved in cell-cell
interactions and their ligands (including without limitation, cellular adhesion molecules (such as
selectins, integrins and their ligands) and receptor/ligand pairs involved in antigen presentation,
10 antigen recognition and development of cellular and humoral immune responses). Receptors and
ligands are also useful for screening of potential peptide or small molecule inhibitors of the
relevant receptor/ligand interaction. A protein of the present invention (including, without
limitation, fragments of receptors and ligands) may themselves be useful as inhibitors of
receptor/ligand interactions.

15 The activity of a protein of the invention may, among other means, be measured by the
following methods:

Suitable assays for receptor-ligand activity include without limitation those described in:
Current Protocols in Immunology, Ed by J. E. Coligan, A. M. Kruisbeek, D. H. Margulies, E.
M. Shevach, W. Strober, Pub. Greene Publishing Associates and Wiley-Interscience (Chapter
20 7.28, Measurement of Cellular Adhesion under static conditions 7.28.1-7.28.22), Takai et al.,
Proc. Natl. Acad. Sci. USA 84:6864-6868, 1987; Bierer et al., J. Exp. Med. 168:1145-1156,
1988; Rosenstein et al., J. Exp. Med. 169:149-160 1989; Stoltenborg et al., J. Immunol. Methods
175:59-68, 1994; Stitt et al., Cell 80:661-670, 1995.

25

6.5.11. ANTI-INFLAMMATORY ACTIVITY

Proteins of the present invention may also exhibit anti-inflammatory activity. The anti-
inflammatory activity may be achieved by providing a stimulus to cells involved in the
inflammatory response, by inhibiting or promoting cell-cell interactions (such as, for example,
30 cell adhesion), by inhibiting or promoting chemotaxis of cells involved in the inflammatory
process, inhibiting or promoting cell extravasation, or by stimulating or suppressing production
of other factors which more directly inhibit or promote an inflammatory response. Proteins
exhibiting such activities can be used to treat inflammatory conditions including chronic or acute

conditions), including without limitation intimation associated with infection (such as septic
5 shock, sepsis or systemic inflammatory response syndrome (SIRS)), ischemia-reperfusion
injury, endotoxin lethality, arthritis, complement-mediated hyperacute rejection, nephritis,
cytokine or chemokine-induced lung injury, inflammatory bowel disease, Crohn's disease or
resulting from over production of cytokines such as TNF or IL-1. Proteins of the invention may
also be useful to treat anaphylaxis and hypersensitivity to an antigenic substance or material.

10

6.5.12. LEUKEMIAS

Leukemias and related disorders may be treated or prevented by administration of a
therapeutic that promotes or inhibits function of the polynucleotides and/or polypeptides of the
invention. Such leukemias and related disorders include but are not limited to acute leukemia,
15 acute lymphocytic leukemia, acute myelocytic leukemia, myeloblastic, promyelocytic,
myelomonocytic, monocytic, erythroleukemia, chronic leukemia, chronic myelocytic
(granulocytic) leukemia and chronic lymphocytic leukemia (for a review of such disorders, see
Fishman et al., 1985, *Medicine*, 2d Ed., J.B. Lippincott Co., Philadelphia).

20

6.5.13. NERVOUS SYSTEM DISORDERS

Nervous system disorders, involving cell types which can be tested for efficacy of
intervention with compounds that modulate the activity of the polynucleotides and/or
polypeptides of the invention, and which can be treated upon thus observing an indication of
therapeutic utility, include but are not limited to nervous system injuries, and diseases or
25 disorders which result in either a disconnection of axons, a diminution or degeneration of
neurons, or demyelination. Nervous system lesions which may be treated in a patient (including
human and non-human mammalian patients) according to the invention include but are not
limited to the following lesions of either the central (including spinal cord, brain) or peripheral
30 nervous systems:

(i) traumatic lesions, including lesions caused by physical injury or associated with
surgery, for example, lesions which sever a portion of the nervous system, or compression
injuries;

- (ii) ischemic lesions, in which a lack of oxygen in a portion of the nervous system results in neuronal injury or death, including cerebral infarction or ischemia, or spinal cord infarction or ischemia;
- (iii) malignant lesions, in which a portion of the nervous system is destroyed or injured by malignant tissue which is either a nervous system associated malignancy or a malignancy derived from non-nervous system tissue;
- (iv) infectious lesions, in which a portion of the nervous system is destroyed or injured as a result of infection, for example, by an abscess or associated with infection by human immunodeficiency virus, herpes zoster, or herpes simplex virus or with Lyme disease, tuberculosis, syphilis;
- (v) degenerative lesions, in which a portion of the nervous system is destroyed or injured as a result of a degenerative process including but not limited to degeneration associated with Parkinson's disease, Alzheimer's disease, Huntington's chorea, or amyotrophic lateral sclerosis;
- (vi) lesions associated with nutritional diseases or disorders, in which a portion of the nervous system is destroyed or injured by a nutritional disorder or disorder of metabolism including but not limited to, vitamin B12 deficiency, folic acid deficiency, Wernicke disease, tobacco-alcohol amblyopia, Marchiafava-Bignami disease (primary degeneration of the corpus callosum), and alcoholic cerebellar degeneration;
- (vii) neurological lesions associated with systemic diseases including but not limited to diabetes (diabetic neuropathy, Bell's palsy), systemic lupus erythematosus, carcinoma, or sarcoidosis;
- (viii) lesions caused by toxic substances including alcohol, lead, or particular neurotoxins; and
- (ix) demyelinated lesions in which a portion of the nervous system is destroyed or injured by a demyelinating disease including but not limited to multiple sclerosis, human immunodeficiency virus-associated myelopathy, transverse myelopathy or various etiologies, progressive multifocal leukoencephalopathy, and central pontine myelinolysis.

Therapeutics which are useful according to the invention for treatment of a nervous

system disorder may be selected by testing for biological activity in promoting the survival or
5 differentiation of neurons. For example, and not by way of limitation, therapeutics which elicit
any of the following effects may be useful according to the invention:

- (i) increased survival time of neurons in culture;
- (ii) increased sprouting of neurons in culture or in vivo;
- (iii) increased production of a neuron-associated molecule in culture or in vivo, e.g.,
10 choline acetyltransferase or acetylcholinesterase with respect to motor neurons; or
- (iv) decreased symptoms of neuron dysfunction in vivo.

Such effects may be measured by any method known in the art. In preferred, non-limiting
embodiments, increased survival of neurons may be measured by the method set forth in
Arakawa et al. (1990, J. Neurosci. 10:3507-3515); increased sprouting of neurons may be
15 detected by methods set forth in Pestronk et al. (1980, Exp. Neurol. 70:65-82) or Brown et al.
(1981, Ann. Rev. Neurosci. 4:17-42); increased production of neuron-associated molecules may
be measured by bioassay, enzymatic assay, antibody binding, Northern blot assay, etc.,
depending on the molecule to be measured; and motor neuron dysfunction may be measured by
assessing the physical manifestation of motor neuron disorder, e.g., weakness, motor neuron
20 conduction velocity, or functional disability.

In a specific embodiments, motor neuron disorders that may be treated according to the
invention include but are not limited to disorders such as infarction, infection, exposure to toxin,
trauma, surgical damage, degenerative disease or malignancy that may affect motor neurons as
25 well as other components of the nervous system, as well as disorders that selectively affect
neurons such as amyotrophic lateral sclerosis, and including but not limited to progressive spinal
muscular atrophy, progressive bulbar palsy, primary lateral sclerosis, infantile and juvenile
muscular atrophy, progressive bulbar paralysis of childhood (Fazio-Londe syndrome),
poliomyelitis and the post polio syndrome, and Hereditary Motorsensory Neuropathy (Charcot-
30 Marie-Tooth Disease).

6.5.14. OTHER ACTIVITIES

A protein of the invention may also exhibit one or more of the following additional

activities or effects: inhibiting the growth, infection or function of, or killing, infectious agents,
5 including, without limitation, bacteria, viruses, fungi and other parasites; effecting (suppressing
or enhancing) bodily characteristics, including, without limitation, height, weight, hair color, eye
color, skin, fat to lean ratio or other tissue pigmentation, or organ or body part size or shape
(such as, for example, breast augmentation or diminution, change in bone form or shape);
effecting biorhythms or circadian cycles or rhythms; effecting the fertility of male or female
10 subjects; effecting the metabolism, catabolism, anabolism, processing, utilization, storage or
elimination of dietary fat, lipid, protein, carbohydrate, vitamins, minerals, co-factors or other
nutritional factors or component(s); effecting behavioral characteristics, including, without
limitation, appetite, libido, stress, cognition (including cognitive disorders), depression
(including depressive disorders) and violent behaviors; providing analgesic effects or other pain
15 reducing effects; promoting differentiation and growth of embryonic stem cells in lineages other
than hematopoietic lineages; hormonal or endocrine activity; in the case of enzymes, correcting
deficiencies of the enzyme and treating deficiency-related diseases; treatment of
hyperproliferative disorders (such as, for example, psoriasis); immunoglobulin-like activity
(such as, for example, the ability to bind antigens or complement); and the ability to act as an
20 antigen in a vaccine composition to raise an immune response against such protein or another
material or entity which is cross-reactive with such protein.

25 6.6. PHARMACEUTICAL FORMULATIONS AND ROUTES OF ADMINISTRATION

A protein of the present invention (from whatever source derived, including without
limitation from recombinant and non-recombinant sources) may be administered to a patient in
need, by itself, or in pharmaceutical compositions where it is mixed with suitable carriers or
30 excipient(s) at doses to treat or ameliorate a variety of disorders. Such a composition may also
contain (in addition to protein and a carrier) diluents, fillers, salts, buffers, stabilizers,
solubilizers, and other materials well known in the art. The term "pharmaceutically acceptable"
means a non-toxic material that does not interfere with the effectiveness of the biological activity

of the active ingredient(s). The characteristics of the carrier will depend on the route of
5 administration. The pharmaceutical composition of the invention may also contain cytokines,
lymphokines, or other hematopoietic factors such as M-CSF, GM-CSF, TNF, IL-1, IL-2, IL-3,
IL-4, IL-5, IL-6, IL-7, IL-8, IL-9, IL-10, IL-11, IL-12, IL-13, IL-14, IL-15, IFN, TNF0, TNF1,
TNF2, G-CSF, Meg-CSF, thrombopoietin, stem cell factor, and erythropoietin. The
pharmaceutical composition may further contain other agents which either enhance the activity
10 of the protein or compliment its activity or use in treatment. Such additional factors and/or
agents may be included in the pharmaceutical composition to produce a synergistic effect with
protein of the invention, or to minimize side effects. Conversely, protein of the present invention
may be included in formulations of the particular cytokine, lymphokine, other hematopoietic
factor, thrombolytic or anti-thrombotic factor, or anti-inflammatory agent to minimize side
15 effects of the cytokine, lymphokine, other hematopoietic factor, thrombolytic or anti-thrombotic
factor, or anti-inflammatory agent. A protein of the present invention may be active in multimers
(e.g., heterodimers or homodimers) or complexes with itself or other proteins. As a result,
pharmaceutical compositions of the invention may comprise a protein of the invention in such
multimeric or complexed form.

20 Techniques for formulation and administration of the compounds of the instant
application may be found in "Remington's Pharmaceutical Sciences," Mack Publishing Co.,
Easton, PA, latest edition. A therapeutically effective dose further refers to that amount of the
compound sufficient to result in amelioration of symptoms, e.g., treatment, healing, prevention
25 or amelioration of the relevant medical condition, or an increase in rate of treatment, healing,
prevention or amelioration of such conditions. When applied to an individual active ingredient,
administered alone, a therapeutically effective dose refers to that ingredient alone. When applied
to a combination, a therapeutically effective dose refers to combined amounts of the active
ingredients that result in the therapeutic effect, whether administered in combination, serially or
30 simultaneously.

In practicing the method of treatment or use of the present invention, a therapeutically
effective amount of protein of the present invention is administered to a mammal having a
condition to be treated. Protein of the present invention may be administered in accordance with

the method of the invention either alone or in combination with other therapies such as
5 treatments employing cytokines, lymphokines or other hematopoietic factors. When co-
administered with one or more cytokines, lymphokines or other hematopoietic factors, protein of
the present invention may be administered either simultaneously with the cytokine(s),
lymphokine(s), other hematopoietic factor(s), thrombolytic or anti-thrombotic factors, or
sequentially. If administered sequentially, the attending physician will decide on the appropriate
10 sequence of administering protein of the present invention in combination with cytokine(s),
lymphokine(s), other hematopoietic factor(s), thrombolytic or anti-thrombotic factors.

6.6.1. ROUTES OF ADMINISTRATION

Suitable routes of administration may, for example, include oral, rectal, transmucosal, or
15 intestinal administration; parenteral delivery, including intramuscular, subcutaneous,
intramedullary injections, as well as intrathecal, direct intraventricular, intravenous,
intraperitoneal, intranasal, or intraocular injections. Administration of protein of the present
invention used in the pharmaceutical composition or to practice the method of the present
invention can be carried out in a variety of conventional ways, such as oral ingestion, inhalation,
20 topical application or cutaneous, subcutaneous, intraperitoneal, parenteral or intravenous
injection. Intravenous administration to the patient is preferred.

Alternately, one may administer the compound in a local rather than systemic manner,
for example, via injection of the compound directly into a arthritic joints or in fibrotic tissue,
25 often in a depot or sustained release formulation. In order to prevent the scarring process
frequently occurring as complication of glaucoma surgery, the compounds may be administered
topically, for example, as eye drops. Furthermore, one may administer the drug in a targeted drug
delivery system, for example, in a liposome coated with a specific antibody, targeting, for
example, arthritic or fibrotic tissue. The liposomes will be targeted to and taken up selectively
30 by the afflicted tissue.

6.6.2. COMPOSITIONS/FORMULATIONS

Pharmaceutical compositions for use in accordance with the present invention thus may

be formulated in a conventional manner using one or more physiologically acceptable carriers comprising excipients and auxiliaries which facilitate processing of the active compounds into preparations which can be used pharmaceutically. These pharmaceutical compositions may be manufactured in a manner that is itself known, *e.g.*, by means of conventional mixing, dissolving, granulating, dragee-making, levigating, emulsifying, encapsulating, entrapping or lyophilizing processes. Proper formulation is dependent upon the route of administration chosen.

10 When a therapeutically effective amount of protein of the present invention is administered orally, protein of the present invention will be in the form of a tablet, capsule, powder, solution or elixir. When administered in tablet form, the pharmaceutical composition of the invention may additionally contain a solid carrier such as a gelatin or an adjuvant. The tablet, capsule, and powder contain from about 5 to 95% protein of the present invention, and preferably from about 15 25 to 90% protein of the present invention. When administered in liquid form, a liquid carrier such as water, petroleum, oils of animal or plant origin such as peanut oil, mineral oil, soybean oil, or sesame oil, or synthetic oils may be added. The liquid form of the pharmaceutical composition may further contain physiological saline solution, dextrose or other saccharide solution, or glycols such as ethylene glycol, propylene glycol or polyethylene glycol. When 20 administered in liquid form, the pharmaceutical composition contains from about 0.5 to 90% by weight of protein of the present invention, and preferably from about 1 to 50% protein of the present invention.

When a therapeutically effective amount of protein of the present invention is administered by intravenous, cutaneous or subcutaneous injection, protein of the present 25 invention will be in the form of a pyrogen-free, parenterally acceptable aqueous solution. The preparation of such parenterally acceptable protein solutions, having due regard to pH, isotonicity, stability, and the like, is within the skill in the art. A preferred pharmaceutical composition for intravenous, cutaneous, or subcutaneous injection should contain, in addition to 30 protein of the present invention, an isotonic vehicle such as Sodium Chloride Injection, Ringer's Injection, Dextrose Injection, Dextrose and Sodium Chloride Injection, Lactated Ringer's Injection, or other vehicle as known in the art. The pharmaceutical composition of the present invention may also contain stabilizers, preservatives, buffers, antioxidants, or other additives

known to those of skill in the art. For injection, the agents of the invention may be formulated in aqueous solutions, preferably in physiologically compatible buffers such as Hanks's solution,
5 Ringer's solution, or physiological saline buffer. For transmucosal administration, penetrants appropriate to the barrier to be permeated are used in the formulation. Such penetrants are generally known in the art.

For oral administration, the compounds can be formulated readily by combining the
10 active compounds with pharmaceutically acceptable carriers well known in the art. Such carriers enable the compounds of the invention to be formulated as tablets, pills, dragees, capsules, liquids, gels, syrups, slurries, suspensions and the like, for oral ingestion by a patient to be treated. Pharmaceutical preparations for oral use can be obtained solid excipient, optionally grinding a resulting mixture, and processing the mixture of granules, after adding suitable
15 auxiliaries, if desired, to obtain tablets or dragee cores. Suitable excipients are, in particular, fillers such as sugars, including lactose, sucrose, mannitol, or sorbitol; cellulose preparations such as, for example, maize starch, wheat starch, rice starch, potato starch, gelatin, gum tragacanth, methyl cellulose, hydroxypropylmethyl-cellulose, sodium carboxymethylcellulose, and/or polyvinylpyrrolidone (PVP). If desired, disintegrating agents may be added, such as the
20 cross-linked polyvinyl pyrrolidone, agar, or alginic acid or a salt thereof such as sodium alginate. Dragee cores are provided with suitable coatings. For this purpose, concentrated sugar solutions may be used, which may optionally contain gum arabic, talc, polyvinyl pyrrolidone, carbopol gel, polyethylene glycol, and/or titanium dioxide, lacquer solutions, and suitable
25 organic solvents or solvent mixtures. Dyestuffs or pigments may be added to the tablets or dragee coatings for identification or to characterize different combinations of active compound doses.

Pharmaceutical preparations which can be used orally include push-fit capsules made of gelatin, as well as soft, sealed capsules made of gelatin and a plasticizer, such as glycerol or
30 sorbitol. The push-fit capsules can contain the active ingredients in admixture with filler such as lactose, binders such as starches, and/or lubricants such as talc or magnesium stearate and, optionally, stabilizers. In soft capsules, the active compounds may be dissolved or suspended in suitable liquids, such as fatty oils, liquid paraffin, or liquid polyethylene glycols. In addition,

stabilizers may be added. All formulations for oral administration should be in dosages suitable for such administration. For buccal administration, the compositions may take the form of tablets or lozenges formulated in conventional manner.

For administration by inhalation, the compounds for use according to the present invention are conveniently delivered in the form of an aerosol spray presentation from pressurized packs or a nebuliser, with the use of a suitable propellant, *e.g.*, dichlorodifluoromethane, trichlorofluoromethane, dichlorotetrafluoroethane, carbon dioxide or other suitable gas. In the case of a pressurized aerosol the dosage unit may be determined by providing a valve to deliver a metered amount. Capsules and cartridges of, *e.g.*, gelatin for use in an inhaler or insufflator may be formulated containing a powder mix of the compound and a suitable powder base such as lactose or starch. The compounds may be formulated for parenteral administration by injection, *e.g.*, by bolus injection or continuous infusion. Formulations for injection may be presented in unit dosage form, *e.g.*, in ampoules or in multi-dose containers, with an added preservative. The compositions may take such forms as suspensions, solutions or emulsions in oily or aqueous vehicles, and may contain formulatory agents such as suspending, stabilizing and/or dispersing agents.

Pharmaceutical formulations for parenteral administration include aqueous solutions of the active compounds in water-soluble form. Additionally, suspensions of the active compounds may be prepared as appropriate oily injection suspensions. Suitable lipophilic solvents or vehicles include fatty oils such as sesame oil, or synthetic fatty acid esters, such as ethyl oleate or triglycerides, or liposomes. Aqueous injection suspensions may contain substances which increase the viscosity of the suspension, such as sodium carboxymethyl cellulose, sorbitol, or dextran. Optionally, the suspension may also contain suitable stabilizers or agents which increase the solubility of the compounds to allow for the preparation of highly concentrated solutions. Alternatively, the active ingredient may be in powder form for constitution with a suitable vehicle, *e.g.*, sterile pyrogen-free water, before use.

The compounds may also be formulated in rectal compositions such as suppositories or retention enemas, *e.g.*, containing conventional suppository bases such as cocoa butter or other glycerides. In addition to the formulations described previously, the compounds may also be

formulated as a depot preparation. Such long acting formulations may be administered by
5 implantation (for example subcutaneously or intramuscularly) or by intramuscular injection.
Thus, for example, the compounds may be formulated with suitable polymeric or hydrophobic
materials (for example as an emulsion in an acceptable oil) or ion exchange resins, or as
sparingly soluble derivatives, for example, as a sparingly soluble salt.

A pharmaceutical carrier for the hydrophobic compounds of the invention is a cosolvent
10 system comprising benzyl alcohol, a nonpolar surfactant, a water-miscible organic polymer, and
an aqueous phase. The cosolvent system may be the VPD co-solvent system. VPD is a solution
of 3% w/v benzyl alcohol, 8% w/v of the nonpolar surfactant polysorbate 80, and 65% w/v
polyethylene glycol 300, made up to volume in absolute ethanol. The VPD co-solvent system
(VPD:5W) consists of VPD diluted 1:1 with a 5% dextrose in water solution. This co-solvent
15 system dissolves hydrophobic compounds well, and itself produces low toxicity upon systemic
administration. Naturally, the proportions of a co-solvent system may be varied considerably
without destroying its solubility and toxicity characteristics. Furthermore, the identity of the co-
solvent components may be varied: for example, other low-toxicity nonpolar surfactants may be
used instead of polysorbate 80; the fraction size of polyethylene glycol may be varied; other
20 biocompatible polymers may replace polyethylene glycol, e.g. polyvinyl pyrrolidone; and other
sugars or polysaccharides may substitute for dextrose. Alternatively, other delivery systems for
hydrophobic pharmaceutical compounds may be employed. Liposomes and emulsions are well
known examples of delivery vehicles or carriers for hydrophobic drugs. Certain organic solvents
25 such as dimethylsulfoxide also may be employed, although usually at the cost of greater toxicity.
Additionally, the compounds may be delivered using a sustained-release system, such as
semipermeable matrices of solid hydrophobic polymers containing the therapeutic agent.
Various of sustained-release materials have been established and are well known by those skilled
in the art. Sustained-release capsules may, depending on their chemical nature, release the
30 compounds for a few weeks up to over 100 days. Depending on the chemical nature and the
biological stability of the therapeutic reagent, additional strategies for protein stabilization may
be employed.

The pharmaceutical compositions also may comprise suitable solid or gel phase carriers

or excipients. Examples of such carriers or excipients include but are not limited to calcium carbonate, calcium phosphate, various sugars, starches, cellulose derivatives, gelatin, and polymers such as polyethylene glycols. Many of the proteinase inhibiting compounds of the invention may be provided as salts with pharmaceutically compatible counterions. Such pharmaceutically acceptable base addition salts are those salts which retain the biological effectiveness and properties of the free acids and which are obtained by reaction with inorganic or organic bases such as sodium hydroxide, magnesium hydroxide, ammonia, trialkylamine, dialkylamine, monoalkylamine, dibasic amino acids, sodium acetate, potassium benzoate, triethanol amine and the like.

The pharmaceutical composition of the invention may be in the form of a complex of the protein(s) of present invention along with protein or peptide antigens. The protein and/or peptide antigen will deliver a stimulatory signal to both B and T lymphocytes. B lymphocytes will respond to antigen through their surface immunoglobulin receptor. T lymphocytes will respond to antigen through the T cell receptor (TCR) following presentation of the antigen by MHC proteins. MHC and structurally related proteins including those encoded by class I and class II MHC genes on host cells will serve to present the peptide antigen(s) to T lymphocytes. The antigen components could also be supplied as purified MHC-peptide complexes alone or with co-stimulatory molecules that can directly signal T cells. Alternatively antibodies able to bind surface immunoglobulin and other molecules on B cells as well as antibodies able to bind the TCR and other molecules on T cells can be combined with the pharmaceutical composition of the invention. The pharmaceutical composition of the invention may be in the form of a liposome in which protein of the present invention is combined, in addition to other pharmaceutically acceptable carriers, with amphipathic agents such as lipids which exist in aggregated form as micelles, insoluble monolayers, liquid crystals, or lamellar layers in aqueous solution. Suitable lipids for liposomal formulation include, without limitation, monoglycerides, diglycerides, sulfatides, lysolecithin, phospholipids, saponin, bile acids, and the like. Preparation of such liposomal formulations is within the level of skill in the art, as disclosed, for example, in U.S. Pat. Nos. 4,235,871; 4,501,728; 4,837,028; and 4,737,323, all of which are incorporated herein by reference.

The amount of protein of the present invention in the pharmaceutical composition of the present invention will depend upon the nature and severity of the condition being treated, and on the nature of prior treatments which the patient has undergone. Ultimately, the attending physician will decide the amount of protein of the present invention with which to treat each individual patient. Initially, the attending physician will administer low doses of protein of the present invention and observe the patient's response. Larger doses of protein of the present invention may be administered until the optimal therapeutic effect is obtained for the patient, and at that point the dosage is not increased further. It is contemplated that the various pharmaceutical compositions used to practice the method of the present invention should contain about 0.01 μ g to about 100 mg (preferably about 0.1 μ g to about 10 mg, more preferably about 0.1 μ g to about 1 mg) of protein of the present invention per kg body weight. For compositions of the present invention which are useful for bone, cartilage, tendon or ligament regeneration, the therapeutic method includes administering the composition topically, systemically, or locally as an implant or device. When administered, the therapeutic composition for use in this invention is, of course, in a pyrogen-free, physiologically acceptable form. Further, the composition may desirably be encapsulated or injected in a viscous form for delivery to the site of bone, cartilage or tissue damage. Topical administration may be suitable for wound healing and tissue repair. Therapeutically useful agents other than a protein of the invention which may also optionally be included in the composition as described above, may alternatively or additionally, be administered simultaneously or sequentially with the composition in the methods of the invention. Preferably for bone and/or cartilage formation, the composition would include a matrix capable of delivering the protein-containing composition to the site of bone and/or cartilage damage, providing a structure for the developing bone and cartilage and optimally capable of being resorbed into the body. Such matrices may be formed of materials presently in use for other implanted medical applications.

The choice of matrix material is based on biocompatibility, biodegradability, mechanical properties, cosmetic appearance and interface properties. The particular application of the compositions will define the appropriate formulation. Potential matrices for the compositions may be biodegradable and chemically defined calcium sulfate, tricalciumphosphate,

hydroxyapatite, polylactic acid, polyglycolic acid and polyanhydrides. Other potential materials
5 are biodegradable and biologically well-defined, such as bone or dermal collagen. Further
matrices are comprised of pure proteins or extracellular matrix components. Other potential
matrices are nonbiodegradable and chemically defined, such as sintered hydroxyapatite,
bioglass, aluminates, or other ceramics. Matrices may be comprised of combinations of any of
the above mentioned types of material, such as polylactic acid and hydroxyapatite or collagen
10 and tricalciumphosphate. The bioceramics may be altered in composition, such as in calcium-
aluminate-phosphate and processing to alter pore size, particle size, particle shape, and
biodegradability. Presently preferred is a 50:50 (mole weight) copolymer of lactic acid and
glycolic acid in the form of porous particles having diameters ranging from 150 to 800 microns.
In some applications, it will be useful to utilize a sequestering agent, such as carboxymethyl
15 cellulose or autologous blood clot, to prevent the protein compositions from disassociating from
the matrix.

A preferred family of sequestering agents is cellulosic materials such as alkylcelluloses
(including hydroxyalkylcelluloses), including methylcellulose, ethylcellulose,
20 hydroxyethylcellulose, hydroxypropylcellulose, hydroxypropyl-methylcellulose, and
carboxymethylcellulose, the most preferred being cationic salts of carboxymethylcellulose
(CMC). Other preferred sequestering agents include hyaluronic acid, sodium alginate,
poly(ethylene glycol), polyoxyethylene oxide, carboxyvinyl polymer and poly(vinyl alcohol).
The amount of sequestering agent useful herein is 0.5-20 wt %, preferably 1-10 wt % based on
25 total formulation weight, which represents the amount necessary to prevent desorption of the
protein from the polymer matrix and to provide appropriate handling of the composition, yet not
so much that the progenitor cells are prevented from infiltrating the matrix, thereby providing
the protein the opportunity to assist the osteogenic activity of the progenitor cells. In further
compositions, proteins of the invention may be combined with other agents beneficial to the
30 treatment of the bone and/or cartilage defect, wound, or tissue in question. These agents include
various growth factors such as epidermal growth factor (EGF), platelet derived growth factor
(PDGF), transforming growth factors (TGF-.alpha. and TGF-.beta.), and insulin-like growth
factor (IGF).

The therapeutic compositions are also presently valuable for veterinary applications. Particularly domestic animals and thoroughbred horses, in addition to humans, are desired patients for such treatment with proteins of the present invention. The dosage regimen of a protein-containing pharmaceutical composition to be used in tissue regeneration will be determined by the attending physician considering various factors which modify the action of the proteins, e.g., amount of tissue weight desired to be formed, the site of damage, the condition of the damaged tissue, the size of a wound, type of damaged tissue (e.g., bone), the patient's age, sex, and diet, the severity of any infection, time of administration and other clinical factors. The dosage may vary with the type of matrix used in the reconstitution and with inclusion of other proteins in the pharmaceutical composition. For example, the addition of other known growth factors, such as IGF I (insulin like growth factor I), to the final composition, may also effect the dosage. Progress can be monitored by periodic assessment of tissue/bone growth and/or repair, for example, X-rays, histomorphometric determinations and tetracycline labeling.

Polynucleotides of the present invention can also be used for gene therapy. Such polynucleotides can be introduced either in vivo or ex vivo into cells for expression in a mammalian subject. Polynucleotides of the invention may also be administered by other known methods for introduction of nucleic acid into a cell or organism (including, without limitation, in the form of viral vectors or naked DNA). Cells may also be cultured ex vivo in the presence of proteins of the present invention in order to proliferate or to produce a desired effect on or activity in such cells. Treated cells can then be introduced in vivo for therapeutic purposes.

6.6.3. EFFECTIVE DOSAGE

Pharmaceutical compositions suitable for use in the present invention include compositions wherein the active ingredients are contained in an effective amount to achieve its intended purpose. More specifically, a therapeutically effective amount means an amount effective to prevent development of or to alleviate the existing symptoms of the subject being treated. Determination of the effective amounts is well within the capability of those skilled in

the art, especially in light of the detailed disclosure provided herein. For any compound used in the method of the invention, the therapeutically effective dose can be estimated initially from
5 cell culture assays. For example, a dose can be formulated in animal models to achieve a circulating concentration range that includes the IC_{50} as determined in cell culture (*i.e.*, the concentration of the test compound which achieves a half-maximal inhibition of the C-proteinase activity). Such information can be used to more accurately determine useful doses in
10 humans.

A therapeutically effective dose refers to that amount of the compound that results in amelioration of symptoms or a prolongation of survival in a patient. Toxicity and therapeutic efficacy of such compounds can be determined by standard pharmaceutical procedures in cell cultures or experimental animals, *e.g.*, for determining the LD_{50} (the dose lethal to 50% of the
15 population) and the ED_{50} (the dose therapeutically effective in 50% of the population). The dose ratio between toxic and therapeutic effects is the therapeutic index and it can be expressed as the ratio between LD_{50} and ED_{50} . Compounds which exhibit high therapeutic indices are preferred. The data obtained from these cell culture assays and animal studies can be used in
20 formulating a range of dosage for use in human. The dosage of such compounds lies preferably within a range of circulating concentrations that include the ED_{50} with little or no toxicity. The dosage may vary within this range depending upon the dosage form employed and the route of administration utilized. The exact formulation, route of administration and dosage can be chosen by the individual physician in view of the patient's condition. *See, e.g.*, Fingl *et al.*,
25 1975, in "The Pharmacological Basis of Therapeutics", Ch. 1 p.1. Dosage amount and interval may be adjusted individually to provide plasma levels of the active moiety which are sufficient to maintain the C-proteinase inhibiting effects, or minimal effective concentration (MEC). The MEC will vary for each compound but can be estimated from *in vitro* data; for example, the
30 concentration necessary to achieve 50-90% inhibition of the C-proteinase using the assays described herein. Dosages necessary to achieve the MEC will depend on individual characteristics and route of administration. However, HPLC assays or bioassays can be used to determine plasma concentrations.

Dosage intervals can also be determined using MEC value. Compounds should be administered using a regimen which maintains plasma levels above the MEC for 10-90% of the time, preferably between 30-90% and most preferably between 50-90%. In cases of local administration or selective uptake, the effective local concentration of the drug may not be related to plasma concentration.

The amount of composition administered will, of course, be dependent on the subject being treated, on the subject's weight, the severity of the affliction, the manner of administration and the judgment of the prescribing physician.

6.6.4. PACKAGING

The compositions may, if desired, be presented in a pack or dispenser device which may contain one or more unit dosage forms containing the active ingredient. The pack may, for example, comprise metal or plastic foil, such as a blister pack. The pack or dispenser device may be accompanied by instructions for administration. Compositions comprising a compound of the invention formulated in a compatible pharmaceutical carrier may also be prepared, placed in an appropriate container, and labelled for treatment of an indicated condition.

6.7. ANTIBODIES

Another aspect of the invention is an antibody that specifically binds the polypeptide of the invention. Such antibodies can be either monoclonal or polyclonal antibodies, as well fragments thereof and humanized forms or fully human forms, such as those produced in transgenic animals. The invention further provides a hybridoma that produces an antibody according to the invention. Antibodies of the invention are useful for detection and/or purification of the polypeptides of the invention.

Protein of the invention may also be used to immunize animals to obtain polyclonal and monoclonal antibodies which specifically react with the protein. Such antibodies may be obtained using either the entire protein or fragments thereof as an immunogen. The peptide immunogens additionally may contain a cysteine residue at the carboxyl terminus, and are conjugated to a hapten such as keyhole limpet hemocyanin (KLH). Methods for synthesizing

such peptides are known in the art, for example, as in R. P. Merrifield, J. Amer. Chem. Soc. 85, 2149-2154 (1963); J. L. Krstenansky, et al., FEBS Lett. 211, 10 (1987). Monoclonal antibodies
5 binding to the protein of the invention may be useful diagnostic agents for the immunodetection of the protein. Neutralizing monoclonal antibodies binding to the protein may also be useful therapeutics for both conditions associated with the protein and also in the treatment of some forms of cancer where abnormal expression of the protein is involved. In the case of cancerous
10 cells or leukemic cells, neutralizing monoclonal antibodies against the protein may be useful in detecting and preventing the metastatic spread of the cancerous cells, which may be mediated by the protein. In general, techniques for preparing polyclonal and monoclonal antibodies as well as hybridomas capable of producing the desired antibody are well known in the art (Campbell, A.M., *Monoclonal Antibodies Technology: Laboratory Techniques in Biochemistry and*
15 *Molecular Biology*, Elsevier Science Publishers, Amsterdam, The Netherlands (1984); St. Groth et al., *J. Immunol.* 35:1-21 (1990); Kohler and Milstein, *Nature* 256:495-497 (1975)), the trioma technique, the human B-cell hybridoma technique (Kozbor et al., *Immunology Today* 4:72 (1983); Cole et al., in *Monoclonal Antibodies and Cancer Therapy*, Alan R. Liss, Inc. (1985), pp. 77-96).

20 Any animal (mouse, rabbit, etc.) which is known to produce antibodies can be immunized with a peptide or polypeptide of the invention. Methods for immunization are well known in the art. Such methods include subcutaneous or intraperitoneal injection of the polypeptide. One skilled in the art will recognize that the amount of the protein encoded by the
25 ORF of the present invention used for immunization will vary based on the animal which is immunized, the antigenicity of the peptide and the site of injection. The protein that is used as an immunogen may be modified or administered in an adjuvant in order to increase the protein's antigenicity. Methods of increasing the antigenicity of a protein are well known in the art and include, but are not limited to, coupling the antigen with a heterologous protein (such as globulin
30 or β -galactosidase) or through the inclusion of an adjuvant during immunization.

For monoclonal antibodies, spleen cells from the immunized animals are removed, fused with myeloma cells, such as SP2/0-Ag14 myeloma cells, and allowed to become monoclonal antibody producing hybridoma cells. Any one of a number of methods well known in the art can

be used to identify the hybridoma cell which produces an antibody with the desired characteristics. These include screening the hybridomas with an ELISA assay, western blot analysis, or radioimmunoassay (Lutz *et al.*, *Exp. Cell Research*. 175:109-124 (1988)). Hybridomas secreting the desired antibodies are cloned and the class and subclass is determined using procedures known in the art (Campbell, A.M., *Monoclonal Antibody Technology: Laboratory Techniques in Biochemistry and Molecular Biology*, Elsevier Science Publishers, Amsterdam, The Netherlands (1984)). Techniques described for the production of single chain antibodies (U.S. Patent 4,946,778) can be adapted to produce single chain antibodies to proteins of the present invention.

For polyclonal antibodies, antibody containing antiserum is isolated from the immunized animal and is screened for the presence of antibodies with the desired specificity using one of the above-described procedures. The present invention further provides the above-described antibodies in detectably labeled form. Antibodies can be detectably labeled through the use of radioisotopes, affinity labels (such as biotin, avidin, etc.), enzymatic labels (such as horseradish peroxidase, alkaline phosphatase, etc.) fluorescent labels (such as FITC or rhodamine, etc.), paramagnetic atoms, etc. Procedures for accomplishing such labeling are well-known in the art, for example, see (Sternberger, L.A. *et al.*, *J. Histochem. Cytochem.* 18:315 (1970); Bayer, E.A. *et al.*, *Meth. Enzym.* 62:308 (1979); Engval, E. *et al.*, *Immunol.* 109:129 (1972); Goding, J.W. *J. Immunol. Meth.* 13:215 (1976)).

The labeled antibodies of the present invention can be used for *in vitro*, *in vivo*, and *in situ* assays to identify cells or tissues in which a fragment of the polypeptide of interest is expressed. The antibodies may also be used directly in therapies or other diagnostics. The present invention further provides the above-described antibodies immobilized on a solid support. Examples of such solid supports include plastics such as polycarbonate, complex carbohydrates such as agarose and sepharose, acrylic resins and such as polyacrylamide and latex beads. Techniques for coupling antibodies to such solid supports are well known in the art (Weir, D.M. *et al.*, *"Handbook of Experimental Immunology"* 4th Ed., Blackwell Scientific Publications, Oxford, England, Chapter 10 (1986); Jacoby, W.D. *et al.*, *Meth. Enzym.* 34 Academic Press, N.Y. (1974)). The immobilized antibodies of the present invention can be used

for *in vitro*, *in vivo*, and *in situ* assays as well as for immuno-affinity purification of the proteins
5 of the present invention.

6.8. COMPUTER READABLE SEQUENCES

In one application of this embodiment, a nucleotide sequence of the present invention
can be recorded on computer readable media. As used herein, "computer readable media" refers
10 to any medium which can be read and accessed directly by a computer. Such media include, but
are not limited to: magnetic storage media, such as floppy discs, hard disc storage medium, and
magnetic tape; optical storage media such as CD-ROM; electrical storage media such as RAM
and ROM; and hybrids of these categories such as magnetic/optical storage media. A skilled
artisan can readily appreciate how any of the presently known computer readable mediums can
15 be used to create a manufacture comprising computer readable medium having recorded thereon
a nucleotide sequence of the present invention. As used herein, "recorded" refers to a process for
storing information on computer readable medium. A skilled artisan can readily adopt any of
the presently known methods for recording information on computer readable medium to
generate manufactures comprising the nucleotide sequence information of the present invention.
20

A variety of data storage structures are available to a skilled artisan for creating a
computer readable medium having recorded thereon a nucleotide sequence of the present
invention. The choice of the data storage structure will generally be based on the means chosen
to access the stored information. In addition, a variety of data processor programs and formats
25 can be used to store the nucleotide sequence information of the present invention on computer
readable medium. The sequence information can be represented in a word processing text file,
formatted in commercially-available software such as WordPerfect and Microsoft Word, or
represented in the form of an ASCII file, stored in a database application, such as DB2, Sybase,
Oracle, or the like. A skilled artisan can readily adapt any number of dataprocessor structuring
30 formats (e.g. text file or database) in order to obtain computer readable medium having recorded
thereon the nucleotide sequence information of the present invention. By providing the
nucleotide sequence of SEQ ID NOS:1, 2 or 5 or a representative fragment thereof, or a
nucleotide sequence at least 99.9% identical to SEQ ID NOS:1, 2 or 5 in computer readable

form, a skilled artisan can routinely access the sequence information for a variety of purposes.

5 Computer software is publicly available which allows a skilled artisan to access sequence information provided in a computer readable medium. The examples which follow demonstrate how software which implements the BLAST (Altschul *et al.*, *J. Mol. Biol.* 215:403-410 (1990)) and BLAZE (Brutlag *et al.*, *Comp. Chem.* 17:203-207 (1993)) search algorithms on a Sybase system is used to identify open reading frames (ORFs) within a nucleic acid sequence. Such

10 ORFs may be protein encoding fragments and may be useful in producing commercially important proteins such as enzymes used in fermentation reactions and in the production of commercially useful metabolites.

As used herein, "a computer-based system" refers to the hardware means, software means, and data storage means used to analyze the nucleotide sequence information of the

15 present invention. The minimum hardware means of the computer-based systems of the present invention comprises a central processing unit (CPU), input means, output means, and data storage means. A skilled artisan can readily appreciate that any one of the currently available computer-based systems are suitable for use in the present invention. As stated above, the

20 computer-based systems of the present invention comprise a data storage means having stored therein a nucleotide sequence of the present invention and the necessary hardware means and software means for supporting and implementing a search means. As used herein, "data storage means" refers to memory which can store nucleotide sequence information of the present invention, or a memory access means which can access manufactures having recorded thereon

25 the nucleotide sequence information of the present invention.

As used herein, "search means" refers to one or more programs which are implemented on the computer-based system to compare a target sequence or target structural motif with the sequence information stored within the data storage means. Search means are used to identify fragments or regions of a known sequence which match a particular target sequence or target

30 motif. A variety of known algorithms are disclosed publicly and a variety of commercially available software for conducting search means are and can be used in the computer-based systems of the present invention. Examples of such software includes, but is not limited to, MacPattern (EMBL), BLASTN and BLASTA (NPOLYPEPTIDEIA). A skilled artisan can

readily recognize that any one of the available algorithms or implementing software packages
5 for conducting homology searches can be adapted for use in the present computer-based
systems. As used herein, a "target sequence" can be any nucleic acid or amino acid sequence of
six or more nucleotides or two or more amino acids. A skilled artisan can readily recognize that
the longer a target sequence is, the less likely a target sequence will be present as a random
occurrence in the database. The most preferred sequence length of a target sequence is from
10 about 10 to 100 amino acids or from about 30 to 300 nucleotide residues. However, it is well
recognized that searches for commercially important fragments, such as sequence fragments
involved in gene expression and protein processing, may be of shorter length.

As used herein, "a target structural motif," or "target motif," refers to any rationally
selected sequence or combination of sequences in which the sequence(s) are chosen based on a
15 three-dimensional configuration which is formed upon the folding of the target motif. There are
a variety of target motifs known in the art. Protein target motifs include, but are not limited to,
enzyme active sites and signal sequences. Nucleic acid target motifs include, but are not limited
to, promoter sequences, hairpin structures and inducible expression elements (protein binding
sequences).

20

6.9. TRIPLE HELIX FORMATION

In addition, the fragments of the present invention, as broadly described, can be used to
control gene expression through triple helix formation or antisense DNA or RNA, both of which
25 methods are based on the binding of a polynucleotide sequence to DNA or RNA.

Polynucleotides suitable for use in these methods are usually 20 to 40 bases in length and are
designed to be complementary to a region of the gene involved in transcription (triple helix - see
Lee et al., Nucl. Acids Res. 6:3073 (1979); *Cooney et al., Science* 15241:456 (1988); and *Dervan*
et al., Science 251:1360 (1991)) or to the mRNA itself (antisense - *Olmno, J. Neurochem.*
30 56:560 (1991); *Oligodeoxynucleotides as Antisense Inhibitors of Gene Expression*, CRC Press,
Boca Raton, FL (1988)). Triple helix- formation optimally results in a shut-off of RNA
transcription from DNA, while antisense RNA hybridization blocks translation of an mRNA
molecule into polypeptide. Both techniques have been demonstrated to be effective in model

systems. Information contained in the sequences of the present invention is necessary for the
5 design of an antisense or triple helix oligonucleotide.

6.10. DIAGNOSTIC ASSAYS AND KITS

The present invention further provides methods to identify the presence or expression of
one of the ORFs of the present invention, or homolog thereof, in a test sample, using a nucleic
10 acid probe or antibodies of the present invention.

In general, methods for detecting a polynucleotide of the invention can comprise
contacting a sample with a compound that binds to and forms a complex with the polynucleotide
for a period sufficient to form the complex, and detecting the complex, so that if a complex is
detected, a polynucleotide of the invention is detected in the sample. Such methods can
15 also comprise contacting a sample under stringent hybridization conditions with nucleic acid
primers that anneal to a polynucleotide of the invention under such conditions, and amplifying
annealed polynucleotides, so that if a polynucleotide is amplified, a polynucleotide of the
invention is detected in the sample.

In general, methods for detecting a polypeptide of the invention can comprise contacting
20 a sample with a compound that binds to and forms a complex with the polypeptide for a period
sufficient to form the complex, and detecting the complex, so that if a complex is detected, a
polypeptide of the invention is detected in the sample.

In detail, such methods comprise incubating a test sample with one or more of the antibodies or
one or more of nucleic acid probes of the present invention and assaying for binding of the
25 nucleic acid probes or antibodies to components within the test sample.

Conditions for incubating a nucleic acid probe or antibody with a test sample vary.
Incubation conditions depend on the format employed in the assay, the detection methods
employed, and the type and nature of the nucleic acid probe or antibody used in the assay. One
30 skilled in the art will recognize that any one of the commonly available hybridization,
amplification or immunological assay formats can readily be adapted to employ the nucleic acid
probes or antibodies of the present invention. Examples of such assays can be found in Chard,
T., *An Introduction to Radioimmunoassay and Related Techniques*, Elsevier Science Publishers,

Amsterdam, The Netherlands (1986); Bullock, G.R. *et al.*, *Techniques in Immunocytochemistry*, Academic Press, Orlando, FL Vol. 1 (1982), Vol. 2 (1983), Vol. 3 (1985); Tijssen, P., *Practice and Theory of immunoassays: Laboratory Techniques in Biochemistry and Molecular Biology*, Elsevier Science Publishers, Amsterdam, The Netherlands (1985). The test samples of the present invention include cells, protein or membrane extracts of cells, or biological fluids such as sputum, blood, serum, plasma, or urine. The test sample used in the above-described method will vary based on the assay format, nature of the detection method and the tissues, cells or extracts used as the sample to be assayed. Methods for preparing protein extracts or membrane extracts of cells are well known in the art and can be readily be adapted in order to obtain a sample which is compatible with the system utilized.

In another embodiment of the present invention, kits are provided which contain the necessary reagents to carry out the assays of the present invention. Specifically, the invention provides a compartment kit to receive, in close confinement, one or more containers which comprises: (a) a first container comprising one of the probes or antibodies of the present invention; and (b) one or more other containers comprising one or more of the following: wash reagents, reagents capable of detecting presence of a bound probe or antibody.

In detail, a compartment kit includes any kit in which reagents are contained in separate containers. Such containers include small glass containers, plastic containers or strips of plastic or paper. Such containers allows one to efficiently transfer reagents from one compartment to another compartment such that the samples and reagents are not cross-contaminated, and the agents or solutions of each container can be added in a quantitative fashion from one compartment to another. Such containers will include a container which will accept the test sample, a container which contains the antibodies used in the assay, containers which contain wash reagents (such as phosphate buffered saline, Tris-buffers, etc.), and containers which contain the reagents used to detect the bound antibody or probe. Types of detection reagents include labeled nucleic acid probes, labeled secondary antibodies, or in the alternative, if the primary antibody is labeled, the enzymatic, or antibody binding reagents which are capable of reacting with the labeled antibody. One skilled in the art will readily recognize that the disclosed probes and antibodies of the present invention can be readily incorporated into one of

the established kit formats which are well known in the art.

5

6.11. SCREENING ASSAYS

Using the isolated proteins and polynucleotides of the invention, the present invention
10 further provides methods of obtaining and identifying agents which bind to a polypeptide
encoded by the ORF from a polynucleotide with a sequence of SEQ ID NOS:1, 2 or 5 to a
specific domain of the polypeptide encoded by the nucleic acid, or to a nucleic acid with a
sequence of SEQ ID NOS:1, 2 or 5. In detail, said method comprises the steps of:

- 15 (a) contacting an agent with an isolated protein encoded by an ORF of the present
invention, or nucleic acid of the invention; and
- (b) determining whether the agent binds to said protein or said nucleic acid.

In general, therefore, such methods for identifying compounds that bind to a
polynucleotide of the invention can comprise contacting a compound with a polynucleotide of
the invention for a time sufficient to form a polynucleotide/compound complex, and detecting
20 the complex, so that if a polynucleotide/compound complex is detected, a compound that binds
to a polynucleotide of the invention is identified.

Likewise, in general, therefore, such methods for identifying compounds that bind to a
polypeptide of the invention can comprise contacting a compound with a polypeptide of the
invention for a time sufficient to form a polypeptide/compound complex, and detecting the
25 complex, so that if a polypeptide/compound complex is detected, a compound that binds to a
polynucleotide of the invention is identified.

Methods for identifying compounds that bind to a polypeptide of the invention can also
comprise contacting a compound with a polypeptide of the invention in a cell for a time
30 sufficient to form a polypeptide/compound complex, wherein the complex drives expression of a
receptor gene sequence in the cell, and detecting the complex by detecting reporter gene
sequence expression, so that if a polypeptide/compound complex is detected, a compound that
binds a polypeptide of the invention is identified.

Compounds identified via such methods can include compounds which modulate the activity of a polypeptide of the invention (that is, increase or decrease its activity, relative to activity observed in the absence of the compound). Alternatively, compounds identified via such methods can include compounds which modulate the expression of a polynucleotide of the invention (that is, increase or decrease expression relative to expression levels observed in the absence of the compound). Compounds, such as compounds identified via the methods of the invention, can be tested using standard assays well known to those of skill in the art for their ability to modulate activity/expression.

The agents screened in the above assay can be, but are not limited to, peptides, carbohydrates, vitamin derivatives, or other pharmaceutical agents. The agents can be selected and screened at random or rationally selected or designed using protein modeling techniques.

For random screening, agents such as peptides, carbohydrates, pharmaceutical agents and the like are selected at random and are assayed for their ability to bind to the protein encoded by the ORF of the present invention. Alternatively, agents may be rationally selected or designed. As used herein, an agent is said to be "rationally selected or designed" when the agent is chosen based on the configuration of the particular protein. For example, one skilled in the art can readily adapt currently available procedures to generate peptides, pharmaceutical agents and the like capable of binding to a specific peptide sequence in order to generate rationally designed antipeptide peptides, for example see Hurby *et al.*, Application of Synthetic Peptides: Antisense Peptides," In *Synthetic Peptides, A User's Guide*, W.H. Freeman, NY (1992), pp. 289-307, and Kaspczak *et al.*, *Biochemistry* 28:9230-8 (1989), or pharmaceutical agents, or the like.

In addition to the foregoing, one class of agents of the present invention, as broadly described, can be used to control gene expression through binding to one of the ORFs or EMFs of the present invention. As described above, such agents can be randomly screened or rationally designed/selected. Targeting the ORF or EMF allows a skilled artisan to design sequence specific or element specific agents, modulating the expression of either a single ORF or multiple ORFs which rely on the same EMF for expression control. One class of DNA binding agents are agents which contain base residues which hybridize or form a triple helix formation by binding to DNA or RNA. Such agents can be based on the classic phosphodiester,

ribonucleic acid backbone, or can be a variety of sulfhydryl or polymeric derivatives which have
5 base attachment capacity.

Agents suitable for use in these methods usually contain 20 to 40 bases and are designed to be complementary to a region of the gene involved in transcription (triple helix - see Lee *et al.*, *Nucl. Acids Res.* 6:3073 (1979); Cooney *et al.*, *Science* 241:456 (1988); and Dervan *et al.*, *Science* 251:1360 (1991)) or to the mRNA itself (antisense - Okano, *J. Neurochem.* 56:560
10 (1991); *Oligodeoxynucleotides as Antisense Inhibitors of Gene Expression*, CRC Press, Boca Raton, FL (1988)). Triple helix- formation optimally results in a shut-off of RNA transcription from DNA, while antisense RNA hybridization blocks translation of an mRNA molecule into polypeptide. Both techniques have been demonstrated to be effective in model systems. Information contained in the sequences of the present invention is necessary for the design of an
15 antisense or triple helix oligonucleotide and other DNA binding agents. Agents which bind to a protein encoded by one of the ORFs of the present invention can be used as a diagnostic agent, in the control of bacterial infection by modulating the activity of the protein encoded by the ORF. Agents which bind to a protein encoded by one of the ORFs of the present invention can be formulated using known techniques to generate a pharmaceutical composition.
20

6.12. USE OF NUCLEIC ACIDS AS PROBES

Another aspect of the subject invention is to provide for polypeptide-specific nucleic acid hybridization probes capable of hybridizing with naturally occurring nucleotide sequences. The
25 hybridization probes of the subject invention may be derived from the nucleotide sequence of the SEQ ID NOS:1, 2 or 5. Because the corresponding gene is only expressed in a limited number of tissues, especially adult tissues, a hybridization probe derived from SEQ ID NOS:1, 2 or 5 can be used as an indicator of the presence of RNA of cell type of such a tissue in a sample.

Any suitable hybridization technique can be employed, such as, for example, in situ
30 hybridization. PCR as described US Patent Nos 4,683,195 and 4,965,188 provides additional uses for oligonucleotides based upon the nucleotide sequences. Such probes used in PCR may be of recombinant origin, may be chemically synthesized, or a mixture of both. The probe will comprise a discrete nucleotide sequence for the detection of identical sequences or a degenerate

pool of possible sequences for identification of closely related genomic sequences.

5 Other means for producing specific hybridization probes for nucleic acids include the cloning of nucleic acid sequences into vectors for the production of mRNA probes. Such vectors are known in the art and are commercially available and may be used to synthesize RNA probes in vitro by means of the addition of the appropriate RNA polymerase as T7 or SP6 RNA polymerase and the appropriate radioactively labeled nucleotides. The nucleotide sequences may
10 be used to construct hybridization probes for mapping their respective genomic sequences. The nucleotide sequence provided herein may be mapped to a chromosome or specific regions of a chromosome using well known genetic and/or chromosomal mapping techniques. These techniques include in situ hybridization, linkage analysis against known chromosomal markers, hybridization screening with libraries or flow-sorted chromosomal preparations specific to
15 known chromosomes, and the like. The technique of fluorescent in situ hybridization of chromosome spreads has been described, among other places, in Verma et al (1988) Human Chromosomes: A Manual of Basic Techniques, Pergamon Press, New York NY.

Fluorescent in situ hybridization of chromosomal preparations and other physical chromosome mapping techniques may be correlated with additional genetic map data. Examples
20 of genetic map data can be found in the 1994 Genome Issue of Science (265:1981f). Correlation between the location of a nucleic acid on a physical chromosomal map and a specific disease (or predisposition to a specific disease) may help delimit the region of DNA associated with that genetic disease. The nucleotide sequences of the subject invention may be used to detect
25 differences in gene sequences between normal, carrier or affected individuals. The nucleotide sequence may be used to produce purified polypeptides using well known methods of recombinant DNA technology. Among the many publications that teach methods for the expression of genes after they have been isolated is Goeddel (1990) Gene Expression Technology, Methods and Enzymology, Vol 185, Academic Press, San Diego. Polypeptides
30 may be expressed in a variety of host cells, either prokaryotic or eukaryotic. Host cells may be from the same species from which a particular polypeptide nucleotide sequence was isolated or from a different species. Advantages of producing polypeptides by recombinant DNA technology include obtaining adequate amounts of the protein for purification and the

availability of simplified purification procedures.

5 Each sequence so obtained was compared to sequences in GenBank using a search algorithm developed by Applied Biosystems and incorporated into the INHERIT™ 670 Sequence Analysis System. In this algorithm, Pattern Specification Language (developed by TRW Inc., Los Angeles, CA) was used to determine regions of homology. The three parameters that determine how the sequence comparisons run were window size, window offset, and error
10 tolerance. Using a combination of these three parameters, the DNA database was searched for sequences containing regions of homology to the query sequence, and the appropriate sequences were scored with an initial value. Subsequently, these homologous regions were examined using dot matrix homology plots to distinguish regions of homology from chance matches. Smith-Waterman alignments were used to display the results of the homology search. Peptide and
15 protein sequence homologies were ascertained using the INHERIT™ 670 Sequence Analysis System in a way similar to that used in DNA sequence homologies. Pattern Specification Language and parameter windows were used to search protein databases for sequences containing regions of homology that were scored with an initial value. Dot-matrix homology plots were examined to distinguish regions of significant homology from chance matches.

20 Alternatively, BLAST, which stands for Basic Local Alignment Search Tool, is used to search for local sequence alignments (Altschul SF (1993) J Mol Evol 36:290-300; Altschul, SF et al (1990) J Mol Biol 215:403-10). BLAST produces alignments of both nucleotide and amino acid sequences to determine sequence similarity. Because of the local nature of the alignments,
25 BLAST is especially useful in determining exact matches or in identifying homologs. Whereas it is ideal for matches which do not contain gaps, it is inappropriate for performing motif-style searching. The fundamental unit of BLAST algorithm output is the High-scoring Segment Pair (HSP). An HSP consists of two sequence fragments of arbitrary but equal lengths whose alignment is locally maximal and for which the alignment score meets or exceeds a threshold or
30 cutoff score set by the user. The BLAST approach is to look for HSPs between a query sequence and a database sequence, to evaluate the statistical significance of any matches found, and to report only those matches which satisfy the user-selected threshold of significance. The parameter E establishes the statistically significant threshold for reporting database sequence

matches. E is interpreted as the upper bound of the expected frequency of chance occurrence of
an HSP (or set of HSPs) within the context of the entire database search. Any database sequence
5 whose match satisfies E is reported in the program output.

In addition, BLAST analysis was used to search for related molecules within the libraries
of the LIFESEQ™ database. This process, an "electronic northern" analysis is analogous to
northern blot analysis in that it uses one cellubrevin sequence at a time to search for identical or
10 homologous molecules at a set stringency. The stringency of the electronic northern is based on
"product score". The product score is defined as (% nucleotide or amino acid [between the
query and reference sequences] in Blast multiplied by the % maximum possible BLAST score
[based on the lengths of query and reference sequences]) divided by 100. At a product score of
40, the match will be exact within a 1-2% error; and at 70, the match will be exact. Homologous
15 or related molecules can be identified by selecting those which show product scores between
approximately 15 and 30.

The present invention is illustrated in the following examples. Upon consideration of the
present disclosure, one of skill in the art will appreciate that many other embodiments and
variations may be made in the scope of the present invention. Accordingly, it is intended that
20 the broader aspects of the present invention not be limited to the disclosure of the following
examples.

7.0. INDUSTRIAL APPLICABILITY:

25 7.1 EXAMPLE 1

A NOVEL NUCLEIC ACID SEQUENCE OBTAINED FROM A CDNA LIBRARY OF FETAL LIVER-SPLEEN ENCODING AN EGF-RECEPTOR LIKE PROTEIN

A plurality of novel nucleic acids were obtained from the b²HFLS20W cDNA library
prepared from human fetal liver-spleen tissue, as described in Bonaldo et al., Genome Res.
30 6:791-806 (1996), using standard pcr, SBH sequence signature analysis and Sanger sequencing
techniques. The inserts of the library were amplified with pcr using primers specific for vector
sequences which flank the inserts. These samples were spotted onto nylon membranes and
interrogated with oligonucleotide probes to give sequence signatures. The clones were clustered

into groups of similar or identical sequences, and single representative clones were selected from each group for gel sequencing. The 5' sequence of the amplified inserts was then deduced using the reverse M13 sequencing primer in a typical Sanger sequencing protocol. PCR products were purified and subjected to fluorescent dye terminator cycle sequencing. Single pass gel sequencing was done using a 377 Applied Biosystems (ABI) sequencer. Two (2) of these inserts have been identified as novel sequences not previously obtained from this library, and not previously reported in public databases. These sequences are shown in Figure 2 as SEQ ID NO: 1-2. The polypeptide sequence corresponding to the nucleic acid sequence of SEQ ID NO: 1 is shown in Figure 2 as SEQ ID NO: 3. The polypeptide sequence corresponding to SEQ ID NO: 2 is shown in Figure 2 as amino acid residues 1-502 of SEQ ID NO: 4 as the designation "NNN" in SEQ ID NO: 2 represents a sequence ambiguity. These amino acid sequences contain EGF motifs that have striking homology to the EGF motifs of *Notch* (from drosophila) and CD97.

Epidermal growth factor and transforming growth factor transmit their signals for cellular growth through EGF-R via an intracellular tyrosine kinase domain. Signaling through EGF induces cell division. Mutated forms of EGF have been demonstrated to be involved in various cancers owing to a lack of regulation in cell division signaling (Carter *et al.*, Crit Rev Oncog 1994;5(4):389-428, Chrysogelos, *et al.*, Breast Cancer Res Treat 1994 Jan;29(1):29-40). This has provided the opportunity to use EGF and other ligands of EGF-R as therapeutic targets for human cancers (Rusch, *et al.*, Cytokine Growth Factor Rev 1996 Aug;7(2):133-141). Mice with targeted mutations to both alleles of the EGF receptor gene die very young after birth from multiorgan failure revealing EGF receptor as essential mammalian protein (Miettinen, *et al.*, Nature 1995 July 27;376():377-341). *Notch* is a receptor protein initially identified in drosophila (Kidd, *et al.*, Mol Cell Biol 1986 Sep;6(9):3094-3108).

The Notch family of transmembrane receptor proteins are key developmental regulators. Mutations in mammalian Notch genes have been implicated in leukaemia, breast cancer, stroke and dementia (Panin, *et al.*, Nature 1997 Jun 26;387(6636):908-912). The extracellular domain of Notch contains 36 EGF-like repeats, a transmembrane domain and three other repetitive elements (Kidd, *et al.*, Mol Cell Biol 1986 Sep;6(9):3094-3108).

CD97 is a surface molecule expressed mainly on leukocytes. It has five EGF-like

domains and seven transmembrane domains, a defining feature of G protein-coupled receptors
5 (Gray, *et al.*, Journal of Immunology 1996 157:5438-5447). It also has a RGD motif (involved
in binding to integrin molecules) and eight potential N-linked glycosylation sites. CD97 has
links to cancer (it is a dedifferentiation marker of human thyroid carcinomas; Aust, *et al.*, Cancer
Res 1997 May 1;57(9):1798-1806) and inflammation (Gray, *et al.*, Journal of Immunology 1996
157:5438-5447).

10

7.2 EXAMPLE 2

EXPRESSION STUDIES WITH SEQ ID NOS 1-2.

To determine if SEQ ID No. 2 is expressed specifically in diseased or normal human
tissues, a Northern blot analysis was performed. The entire cDNA insert was labelled with
15 radioisotope using a multiprime labeling method. A high stringency wash was performed to
ensure specific hybridization. The resultant hybridization pattern produced a total of five
different bands (approximately 6.5, 4.0, 2.1, 0.5 and 0.2 kb). Two of these bands (6.5 and 4 kb)
are *uniquely* expressed in a sample derived from a brain tumor (Astrocytoma of cerebellum) and
not in a panel of samples from 19 other tissues (normal brain, kidney tumor and normal kidney,
20 liver tumor and normal liver, lung tumor and normal lung, normal heart, pancreas spleen and
skeletal muscle and fetal brain, liver, lung, and skeletal muscle). The other 3 bands are
expressed to varying degrees in the other tissues. These results indicate that the two higher
molecular weight bands are specific to the brain tumor tissue and not to the other samples
25 surveyed. As EGF-motif containing receptors have been previously been linked to the
progression of various cancers, we believe that the full length message to SEQ ID No. 2 is
involved in brain tumor development.

7.3 EXAMPLE 3

30 USE OF MOLECULES WHICH BIND SEQ ID NOS. 3-4

Molecules which bind SEQ ID Nos. 3, 4, 6 or amino acid residues 1-502 of SEQ ID NO:
4 will include, e.g., monoclonal antibodies and other small molecules which act as blocking
agents, or as activators. *See above.* These molecules are identified as agonists or antagonists of

SEQ ID Nos. 3, 4, 6 or amino acid residues 1-502 of SEQ ID NO: 4 by the following types of
5 assays. Tumor cell lines which are well known in the art, e.g., astrocytoma cell line 1321N1, are
cultured in the presence of the binding molecules, and antagonist or agonist activity is identified
by changes in the growth rate of the tumor cells. In one embodiment, the binding molecule is an
antagonist which causes cell death.

Antibodies or other suitable binding molecules which bind to SEQ ID Nos. 3, 4, 6 or
10 amino acid residues 1-502 of SEQ ID NO: 4 are also useful in receptor protein purification and
for *in situ* hybridization analyses. Initial *in situ* analyses identify associations between the
expression of SEQ ID Nos. 3, 4, 6 or amino acid residues 1-502 of SEQ ID NO: 4 and genetic
disorders of the immune system or development. *In situ* hybridization with these binding
molecules then diagnoses these genetic disorders of the immune system or development in
15 patients.

7.4 EXAMPLE 4

SEQ ID NOS. 5 and 6

SEQ ID NO. 5 (Figure 4) is a 5' and 3' extension of the original cDNA sequence, SEQ
20 ID NO. 2. In the 5' direction, additional sequence was obtained by a PCR based method of
extending 5' sequence information from truncated cDNAs called 5' RACE (Rapid Amplification
of cDNA Ends) (Frohman, M.A., Dush, M.K. and Martin, G.R., (1988) *Proc. Natl. Acad. Sci.*
USA 85, 8998-9002). Fetal Liver Marathon-Ready cDNA (Clontech) was used as template for
25 PCR reactions. Adaptor primer AP1 provided by Clontech was used as the 5' PCR primer, a
gene-specific primer 10244-52 (5' - CTCATCCTCAAGCCCCTCTTT-3') was used as the 3'
PCR primer. The products of this PCR reaction were diluted 100 fold and used as a template for
a nested PCR reaction with AP1 as the 5' primer and another gene specific primer 10244-51 (5'
- CCATGAGAGTTCCCGCCTCTG-3') as the 3' primer. The products of this PCR reaction
30 were cloned into the pGEM®-T Easy vector using the pGEM®-T Easy Vector System
(Promega) as instructed in the user manual. Bacterial suspensions of individual colonies derived
from this cloning reaction were used as template for PCR reactions using vector primers (T7: 5'
- GTAATACGACTCACTATAGGG-3', SP6: 5' - ATTTAGGTGACACTATAGAAGG-3') to

generate DNA fragments for sequencing reactions. Using the same primers as in the PCR
 5 reactions (T7 and SP6), these DNA fragments were sequenced using the BigDYE terminator
 (Perkin Elmer ABI) cycle sequencing reactions (Sanger dideoxy). 138 nucleotides are
 contiguous with the original cDNA sequence SEQ ID NO: 2 on the 5' end. Based on these
 additional sequences, two additional gene specific primers were designed (10244-A: 5' -
 CCCAGGCTGACGTGCCGATGC-3', 10244-B: 5' - GCAGCAGGCCAGTTTAGTTCC-3'),
 10 and these were used to repeat the 5' RACE process.

Fetal Liver Marathon-Ready cDNA (Clontech) was used again as template for PCR
 reactions with primers AP1 and the gene-specific primer 10244-B. The products of this PCR
 reaction were used as a template for the nested PCR reaction with AP1 as the 5' primer and the
 gene specific primer 10244-A as the 3' primer. The products of this PCR reaction were similarly
 15 cloned into the pGEM®-T Easy vector and inserts of individual colonies were similarly
 sequenced. Additional nucleotide sequences were obtained from sequencing reactions that
 produced sequences that are contiguous with the sequence obtained above to complete SEQ ID
 NO. 5 (2365bp) as shown in Figure 4.

SEQ ID NO: 6 (Figure 5) is the amino-acid translation from nucleotide 205 to 1866 of
 20 SEQ ID NO: 5, including the starting methionine and stop codon. The first 21 amino-acids
 comprise the hydrophobic region that represents the signal peptide. EGF motifs are located at
 amino acid residues 80-93 of SEQ ID NO:6 (EGF motif 1), amino acid residues 95-128 of SEQ
 ID NO:6 (EGF motif 2), amino acid residues 133-168 of SEQ ID NO:6 (EGF motif 3), amino
 25 acid residues 175-214 of SEQ ID NO:6 (EGF motif 4), amino acid residues 220-259 (EGF motif
 5). A transmembrane domain is located at amino acid residues 446-465 of SEQ ID NO:6, a
 potential phosphorylation site at amino acid residue 509 of SEQ ID NO: 6, and a RGD motif at
 amino acid residues 363-365 of SEQ ID NO:6

Thus, SEQ ID No. 1 encodes the polypeptide sequence of SEQ ID Nos. 3 which contains
 30 EGF motifs that are similar to the EGF motif of the drosophila developmental gene *Notch*
 (32% amino acid sequence homology), the EGF motif of CD97 (38% amino acid sequence
 homology), and the EGF consensus motif (26% amino acid homology). SEQ ID No 1 is an EST
 for a family member of the EGF-containing genes with most similarity to the EGF motifs of

drosophila *Notch* and human CD97.

5 Likewise SEQ ID No. 5 encodes the polypeptide sequence of SEQ ID No. 6 which is similar in protein sequence to the EGF motif of the drosophila developmental gene *Notch* (31% amino acid sequence homology), the EGF motif of CD97 (34% amino acid sequence homology), and the EGF consensus motif (24% amino acid homology).

In general, the content and position of certain certain highly conserved amino acid
10 residues identifies SEQ ID No. 6 as a member of the EGF-repeat containing family (conserved amino acid residues are shown in Figure 1). Six cysteines and two glycines are highly conserved among EGF- repeats which define an EGF motif. Four cysteines and one glycine are absolutely conserved in the consensus sequence from known EGF-repeat domains. The four and a half EGF motifs in SEQ ID No. 6 contain the cysteines and the one glycine residue with the
15 appropriate spacing between these residues. Thus, SEQ ID No. 6 is properly classified as a protein containing the EGF-repeat motif. SEQ ID No. 6 has the highest amino acid similarity to CD97, but the conserved residues of the motif are most similar to drosophila *Notch*.

The present invention is not to be limited in scope by the exemplified embodiments
20 which are intended as illustrations of single aspects of the invention, and compositions and methods which are functionally equivalent are within the scope of the invention. Indeed, numerous modifications and variations in the practice of the invention are expected to occur to those skilled in the art upon consideration of the present preferred embodiments. Consequently,
25 the only limitations which should be placed upon the scope of the invention are those which appear in the appended claims.

All references cited within the body of the instant specification are hereby incorporated by reference in their entirety.

WHAT IS CLAIMED IS:

- 5 1. An isolated polynucleotide comprising:
- a) a nucleotide sequence encoding a polypeptide comprising the amino acid
 sequence of SEQ ID NO:6;
- b) a nucleotide sequence encoding a polypeptide comprising amino acid
 residues 1-21 of SEQ ID NO:6;
- 10 c) a nucleotide sequence encoding a polypeptide comprising amino acid
 residues 80-93 of SEQ ID NO:6;
- d) a nucleotide sequence encoding a polypeptide comprising amino acid
 residues 95-128 of SEQ ID NO:6;
- 15 e) a nucleotide sequence encoding a polypeptide comprising amino acid
 residues 133-168 of SEQ ID NO:6;
- f) a nucleotide sequence encoding a polypeptide comprising amino acid
 residues 175-214 of SEQ ID NO:6;
- g) a nucleotide sequence encoding a polypeptide comprising amino acid
 residues 220-259 of SEQ ID NO:6;
- 20 h) a nucleotide sequence encoding a polypeptide comprising amino acid
 residues 446-465 of SEQ ID NO:6;
- i) a nucleotide sequence encoding a polypeptide comprising amino acid
 residues 363-365 of SEQ ID NO:6;
- 25 j) a nucleotide sequence encoding a polypeptide comprising the amino acid
 sequence encoded by the cDNA insert of clone pEGFR-HY2, the nucleic
 acids 323-357 of SEQ ID NO:5, and the cDNA insert of clone pEGFR-
 HY1;
- k) a nucleotide sequence comprising the full length protein coding sequence
30 of the cDNA insert of clone pEGFR-HY2, the nucleic acids 323-357 of
 SEQ ID NO:5, and the cDNA insert of clone pEGFR-HY1;
- l) a nucleotide sequence encoding the mature protein encoded by the cDNA
 insert of clone pEGFR-HY2, the nucleic acids 323-357 of SEQ ID NO:5,

- and the cDNA insert of clone pEGFR-HY1;
- 5 m) the nucleotide sequence of SEQ ID NO:5;
- n) nucleotides 205-267 of the nucleotide sequence of SEQ ID NO:1;
- o) nucleotides 442-483 of the nucleotide sequence of SEQ ID NO:1;
- p) nucleotides 487-588 of the nucleotide sequence of SEQ ID NO:1;
- q) nucleotides 601-708 of the nucleotide sequence of SEQ ID NO:1;
- 10 r) nucleotides 727-846 of the nucleotide sequence of SEQ ID NO:5;
- s) nucleotides 862-981 of the nucleotide sequence of SEQ ID NO:5;
- t) nucleotides 1540-1599 of the nucleotide sequence of SEQ ID NO:5;
- u) nucleotides 1729-1731 of the nucleotide sequence of SEQ ID NO:5;
- v) nucleotides 1291-1299 of the nucleotide sequence of SEQ ID NO:5;
- 15 w) the nucleotide sequence of the cDNA insert of clone pEGFR-HY1; or
- x) the nucleotide sequence of the cDNA insert of clone pEGFR-HY2.

2. An isolated polynucleotide which hybridizes to the complement of the
polynucleotide of Claim 1 under stringent hybridization conditions.

20

3. An isolated polynucleotide which comprises the complement of the
polynucleotide of Claim 1.

25 4. A vector comprising the isolated polynucleotide of Claim 1 or 2.

5. An expression vector comprising the isolated polynucleotide of Claim 1 or 2.

6. A host cell genetically engineered to contain the polynucleotide of Claim 1 or 2.

30

7. A host cell genetically engineered to contain the polynucleotide of Claim 1 or 2
in operative association with a regulatory sequence that controls expression of the
polynucleotide in the host cell.

- 5 8. An isolated polypeptide comprising:
- a) the amino acid sequence of SEQ ID NO:6;
- b) amino acid residues 1-21 of SEQ ID NO:6;
- c) amino acid residues 80-93 of SEQ ID NO:6;
- d) amino acid residues 95-128 of SEQ ID NO:6;
- 10 e) amino acid residues 133-168;
- f) amino acid residues 175-214;
- g) amino acid residues 220-259;
- h) amino acid residues 446-465;
- i) amino acid residues 363-365;
- 15 j) the amino acid sequence encoded by the cDNA insert of clone pEGFR-HY2, the nucleic acids 323-357 of SEQ ID NO:5, and the cDNA insert of clone pEGFR-HY1;
- k) an amino acid sequence comprising the full length protein encoded by the cDNA insert of clone pEGFR-HY2, the nucleic acids 323-357 of SEQ ID NO:5, and the cDNA insert of clone pEGFR-HY1; or
- 20 l) a polypeptide comprising the mature protein encoded by the cDNA insert of clone pEGFR-HY2, the nucleic acids 323-357 of SEQ ID NO:5, and the cDNA insert of clone pEGFR-HY1.
- 25 9. A composition comprising the polypeptide of Claim 8 and a carrier.
10. An antibody directed against the polypeptide of Claim 8.
- 30 11. A method for detecting a polynucleotide of Claim 1 or 2 in a sample, comprising:
- a) contacting the sample with a compound that binds to and forms a complex with the polynucleotide for a period sufficient to form the complex; and
- b) detecting the complex,

so that if a complex is detected, a polynucleotide of Claim 1 or 2 is detected.

5

12. A method for detecting a polynucleotide of Claim 1 or 2 in a sample, comprising:

a) contacting the sample under stringent hybridization conditions with nucleic acid primers that anneal to a polynucleotide of Claim 1 or 2 under such conditions; and

10

b) amplifying the annealed polynucleotides,

so that if a polynucleotide is amplified, a polynucleotide of Claim 1 or 2 is detected.

13. The method of Claim 12, wherein the polynucleotide is an RNA molecule that encodes a polypeptide of Claim 8, and the method further comprises reverse transcribing an
15 annealed RNA molecule into a cDNA polynucleotide.

14. A method for detecting a polypeptide of Claim 8 in a sample, comprising:

a) contacting the sample with a compound that binds to and forms a complex with the polypeptide for a period sufficient to form the complex; and

20

b) detecting the complex,

so that if a complex is detected, a polypeptide of Claim 8 is detected.

15. A method for identifying a compound that binds to a polypeptide of Claim 8,
25 comprising:

a) contacting a compound with a polypeptide of Claim 8 for a time sufficient to form a polypeptide/compound complex; and

b) detecting the complex,

so that if a polypeptide/compound complex is detected, a compound that binds to a polypeptide
30 of Claim 8 is identified.

16. A method for identifying a compound that binds to a polypeptide of Claim 8, comprising:

- 5 a) contacting a compound with a polypeptide of Claim 8, in a cell, for a time sufficient to form a polypeptide/compound complex, wherein the complex drives expression of a reporter gene sequence in the cell; and
- b) detecting the complex by detecting reporter gene sequence expression, so that if a polypeptide/compound complex is detected, a compound that binds to a polypeptide of Claim 8 is identified.

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17. A method of modulating activity of a polypeptide of Claim 8, comprising contacting a cell that expresses the polypeptide with a compound that modulates activity of the polypeptide for a time sufficient to modulate said activity.

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18. A method of modulating activity of the polypeptide of Claim 8, comprising contacting the polypeptide with a compound that modulates activity of the polypeptide for a time sufficient to modulate said activity.

20

19. A method of producing the polypeptide of claim 8, comprising,

- a) culturing the host cell of claim 7 for a period of time sufficient to express the polypeptide contained within said cell; and
- b) isolating the peptide from the cell of step (a).

25

20. An isolated polynucleotide comprising the nucleic acid sequence of SEQ ID NOS: 1, 2 or 5.

30

21. An isolated polypeptide comprising the amino acid sequence of SEQ ID NOS: 3, 4, 6 or amino acid residues of 1-502 of SEQ ID NO:4.

Notch(C)	IDEQ-SNP	CONGGTC---D-VGSY-C-CPPGFT	GK---CE-N
10241(C)	-NECTM---	CQH---C	VNT-GSY-CKC-SG'-
80			CRGFPGYT
95	VNEQGMKPRP	CQHR C	VNTHGSKCFCLLS
133	VNSRTCAMIN	CQYS C	EDTEEGPQCLCPSS
175	IDEGASGKVI	CPYNRRC	VNTFGSYCKCHIGFE
220	INECTMDSHT	CSHHANC	FNTQGSF CKCKQGYK
CD97(C)	V-EQ-SG-Q--C-SS--C	-NTVGSY-CRCRPGW-P-PG-PN---	D
EGF(C)	NSDSECP LSHDGYCLHDGVCMYIEALDKYACNCVGYI---	GER--CQYRDLKMWELR	

Figure 1

GGCTGGAGAA GAAACAGCAA GGGAGTCTGT GAAGCTACAT GCGAACTGG
ATGTAAGTTT GGTGAGTGCG TGGGACCAAA CAAATGCAGA TGCTTTTCAG
GATACACCGG GAAAACCTGC AGTCAAGATG TGAATGAGTG TGGAAAGAAA
CCCCGGCCAT GCCAACACAG ATGTGTGAAT ACACACGGAA GCTACAAGTG
CTTTTGCCCTC AGTGGCCACA TGCTCATGCC AGATGCTACG TGTGTGAACT
CNAGGACATG TGCCATGATA AACTGTCAGT ATAGCTGTGA AGACACAGAA
(SEQ ID NO 1)

GGCTGGAGAA GAAACAGCAA GGGAGTCTGT GAAGCTACAT GCGAACCTGG
ATGTAAGTTT GGTGAGTGCG TGGGACCAAA CAAATGCAGA TGCTTTCCAG
GATACACCGG GAAAACCTGC AGTCAAGATG TGAATGAGTG TGGAAAGAAA
CCCCGGCCAT GCCAACACAG ATGTGTGAAT ACACACGGAA GCTACAAGTG
CTTTTGCCCTC AGTGGCCACA TGCTCATGCC AGATGCTACG TGTGTGAACT
CNAGGACATG TGCCATGATA AACTGTCAGT ATAGCTGTGA AGACACAGAA
GAAGGGCCAC AGTGCTGTG TCCATCCTCA GGACTCCGCC TGGCCCCAAA
TGGAAGAGAC TGTCTAGATA TTGATGAATG TGCCTCTGGT AAAGTCATCT
GTCCCTACAA TCGAAGATGT GTGAACACAT TTGGAAGCTA CTAAGTCAAA
TGTCACATTG GTTTCGAACT GCAATATATC AGTGGACGAT ATGACTGTAT
AGATATAAAT GAATGTACTA TGGATAGCCA TACGTGCAGC CACCATGCCA
ATTGCTTCAA TACCCAAGGG TCCTTCAAGT GTAAATGCAA GCAGGGATAT
AAAGGCAATG GACTTCGGTG TTCTGCTATC CCTGAAAATT CTGTGAAGGA
AGTCCTCAGA GCACCTGGTA CCATCAAAGA CAGAATCAAG AAGTTGCTTG
CTCACAAAAA CAGCATGAAA AAGAAGGCAA AAATTAAGAA TGTTACCCCA
GAACCCACCA GGACTCCTAC CCCTAAGGTG AACTTGCAGC CCTTCAACTA
TGAAGAGATA GTTTCAGAG GCGGGAATC TCATGGAGGT AAAAAAGGGA
ATGAAGAGAA AATGAAAGAG GGGCTTGAGG ATGAGAAAAG AGAAGAGAAA
GCCCTGAAGA ATGACATAGA GGAGCGAAGC CTGCGAGGAG ATGTGTTTTT
CCCTAAGGTG AATGAAGCAG GTGAATTCGG CCTGATTCTG GTCCAAAGGA
AAGCGCTAAC TTCCAACTG GAACATAAAG ATTTAAATAT CTCGGTGGAC
TGCAGCTTCA ATCATGGGAT CTGTGACTGG AAACAGGATA GAGAAGATGA
TTTTGACTGG AATCCTGCTG ATCGAGATAA TGCTATTGGC TTCTATATGG
CAGTTCCGGC CTGGGCAGGT CACATGAAAG ACATTGGCCG ATTGAAACTT
CTCCTACCTG ACCTGCAACC CCAAAGCAAC TTCTGTTTGC TCTTTGATTA
CCGGCTGGCC GGAGACAAAG TCGGGAAACT TCGAGTGTTT GTGAAAACAA
GTAACAATGC CCTGGCATGG GAGAAGACCA CGAGTGAGGA TGAAAAGTGG
AAGACAGGGA AAATTCAGTT GTATCAAGGA ACTGATGCTA CAAAAAGCAT
CATTTTTGAA GCAGAACGTG GCAAGGGCAA AACCGGCGAA ATCGCAGTGG
ATGGCGTCTT GCTTGTTTCA GGCTTATGTC CAGATAGCCT TTTATCTGIG
GANNNCTGAA TGGTACTATC TTTATATTTG ACTTTGTATG TCAGTTCCCT
GGTTTTTTTG ATATTGCATC ATAGGACCTC TGGCATTTTA AAATTACTAG
CTGAAAAATT G
(SEQ ID NO 2)

Figure 2

GWRRNSKGVCEATCEPGCKFGECVGPNNKCRCPGYTGKTCSDVNECGMKPRPCQHR
CVNTHGSYKCFCLSGHMLMPDATCVNSRTCAMINCQYSCEDTE
(SEQ ID NO 3)

GWRRNSKGVCEATCEPGCKFGECVGPNNKCRCPGYTGKTCSDVNECGMKPRPCQHR
CVNTHGSYKCFCLSGHMLMPDATCVNSRTCAMINCQYSCEDTEEGPQCLCPSSGLRLAP
NGRDCLDIDECASGKVICPYNRRCVNTFGSYCKCHIGFELQYISGRYDCIDINECTMDS
HTCSHHANCFNTQGSFKCKKQGYKGNGLRCSAIPENSVKEVLRAPGTIKDRIKKLLAH
KNSMKKKAKIKNVTPETRTPTPKVNLQPFNYEEIVSRGGNSHGGKKGNEEKMKEGLE
DEKREEKALKNDIEERSLRGDVFFPKVNEAGEFGLILVQRKALTSKLEHKDLNISVDCSF
NHGICDWKQDREDDFDWNPADRDNAIGFYMAVPALAGHMKDIGRLKLLPDLPQPSN
FCLLFDYRLAGDKVGKLRVFKNSNNALAWKTTSEDEKWKTKIQLYQGTDATKSIIF
EAERGKGKTGEIADVGVLLVSGLCPSLLSVDDX.MVLSLYLTLVYSSLVFLILHRTSGI
LKLLAEKL
(SEQ ID NO 4)

Figure 3

(SEQ ID NO: 5)

(SEQ ID NO: 6)

INTERNATIONAL SEARCH REPORT

Inter. Application No

PCT/US 98/24524

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 C12N15/12 C12N5/10 C07K14/705 C07K16/28 C12Q1/68
G01N33/566 A61K38/17 //C07K14/715

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 C12N C07K C12Q G01N A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
E	WO 99 06553 A (LACROIX BRUNO ;DUCLERT AYMERIC (FR); GENSET (FR); DUMAS MILNE EDWA) 11 February 1999 see abstract see claims 1-37 compare aa 1-57 of seq.ID 6 of present application and seq. ID 19 of W09906553 ---	1-8
X	DATABASE GENBANK Accession No. R99817, 14 September 1995 HILLIER L. ET AL.: "EST; H. sapiens cDNA clone IMAGE:201021 similar to Fibrillin 1" XP002096250 encodes aa 150-295 of seq. ID 6 --- -/--	1-21

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"S" document member of the same patent family

Date of the actual completion of the international search

11 March 1999

Date of mailing of the international search report

23/03/1999

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INTERNATIONAL SEARCH REPORT

Inter. Application No

PCT/US 98/24524

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>DATABASE GENBANK Accession No. AA025649, 14 August 1996 HILLIER L. ET AL.: "EST; H. sapiens cDNA clone IMAGE:365765" XP002096251 encodes aa 320-508 of seq. ID 6 ---</p>	1-21
X	<p>DATABASE GENBANK Accession No. AA436507, 30 May 1997 HILLIER ET AL.: "EST; H. sapiens cDNA clone IMAGE:753036" XP002096252 encodes aa 403-553 of seq. ID 6 ---</p>	1-21
A	<p>WO 92 19734 A (INDIANA UNIVERSITY FOUNDATION ;UNIV YALE (US)) 12 November 1992 see abstract see claims 1,62-67,76-79,81,82 see claims 95,96,103,104,111,112 see claim 120 ---</p>	1-21
A	<p>MCKNIGHT A J ET AL: "EGF-TM7: a novel subfamily of seven-transmembrane-region leukocyte cell-surface molecules" IMMUNOLOGY TODAY, vol. 17, no. 6, June 1996, page 283-287 XP004034613 see the whole document -----</p>	1-21

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 98/24524

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☒ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
The modulator of claims 17 and 18 is not sufficiently described to allow a meaningful and complete search. As far as a method in vivo is envisaged, claim 17 is directed to a method of treatment: the search has been based only on the alleged effects of the compound.
2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims: it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 98/24524

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 9906553	A	11-02-1999	NONE	
WO 9219734	A	12-11-1992	AU 675203 B	30-01-1997
			AU 1919792 A	21-12-1992
			CA 2102208 A	12-11-1992
			EP 0576623 A	05-01-1994
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			US 5856441 A	05-01-1999
			US 5789195 A	04-08-1998